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RUSCHENBERGER'S SERIES.

FIRST BOOKS OF NATURAL HISTORY.

ELEMENTS OF ENTOMOLOGY:

PREPARED FOR THE USE OF

SCHOOLS AND COLLEGES,

BY

W. S. W. RUSCHENBERGER, M.D.

SURGEON IN THE U. S. NAVY; FELLOW OF THE COLLEGE OF PHYSICIANS; OF
MEMBER OF THE PHILADELPHIA MEDICAL SOCIETY; MEMBER OF THE
ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, ETC., ETC.

FROM THE TEXT OF

MILNE EDWARDS AND ACHILLE COMTÉ,

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WITH PLATES.

PHILADELPHIA:
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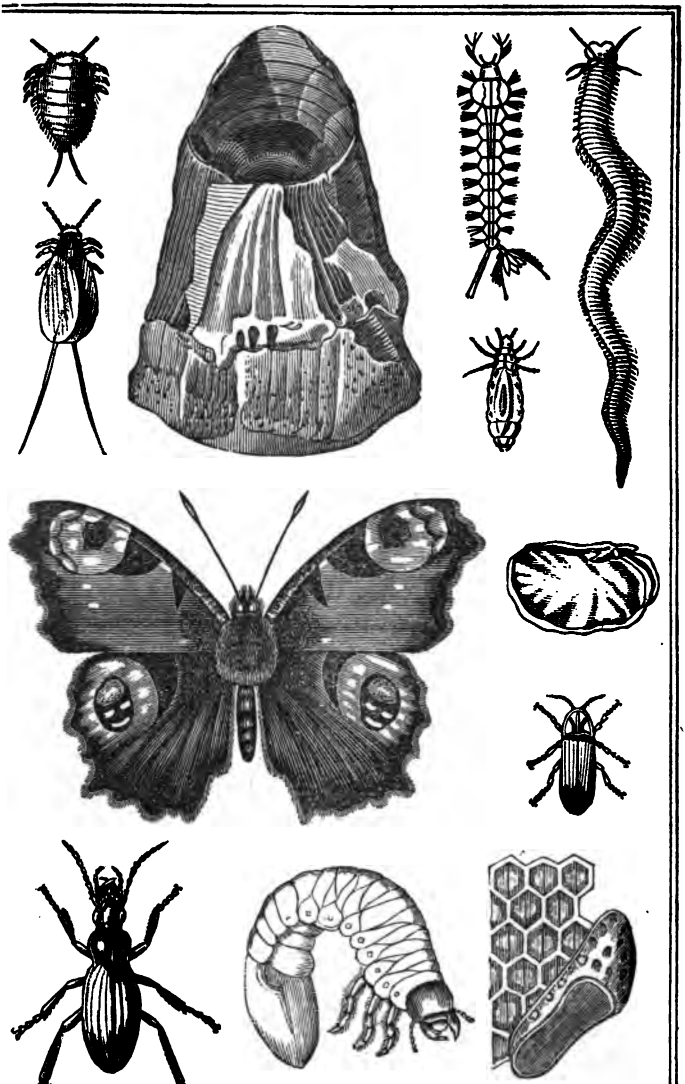

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PREFACE.

THE sixth in the series of "FIRST BOOKS of NATURAL HISTORY," includes a consideration of Articulated Animals, Insects, My'riapods, Arach'nidans, Crusta'ceans, Cirr'hopods, Anne'lidans, and Zo'ophytes, or radiated animals.

The volume is illustrated by ninety-one beautiful wood-cuts, executed in his best style, by Mr. G. Thomas, of Philadelphia.

The etymology of technical words is explained in the text; and a full Glossary is also appended.

In the preparation of this volume, besides the text of Edwards and Comte, the works of Cuvier, Lamarck, T. Rymer Jones, Thomas Say, and others, have been freely used.

The writer takes great pleasure in believing that in supplying a series of elementary books on natural history, his humble labours may be beneficial to the country. As a useful branch of education, natural history seems not to be sufficiently appreciated, or extensively regarded.

By the term Natural History, we mean that science which embraces a knowledge of the structure of all bodies, whether living or inorganic, found on the whole face of the earth, or united together to constitute its mass; a knowledge of the phenomena observable in these bodies, the characteristics by which they may be distinguished from each other, and the parts they perform in the great total of the creation. Its domain is immense, and its importance does not yield to its extent. Some men, possessing little acquaintance with science, perceive in it a mere collection of anecdotes, more fitted to gratify idle curiosity than to exercise the mind; or they regard it as a dry study of technical names and arbitrary classifications; but such an opinion has its source in ignorance, for no one possessing the most elementary notions of natural history can fail to recognise its great utility. The spectacle of nature, grand and harmonious as it is, showing how vastly superior in beauty the reality of the creation is to the most magnificent of human inventions, elevates and disposes the mind to high and salutary thoughts. A knowledge of ourselves, and of the objects which surround us, is not merely to satisfy our craving for information—a craving which is developed in proportion to the increase of intelligence: it is a necessary foundation for many other studies, and is eminently calculated to impart that rectitude of judgment without which the most brilliant qualities lose their value, and, in the course of life, rather lead from them conduct us to useful conclusions. The importance of the natural sciences ought to be too evident to require demonstration. Geology and mineralogy render daily services to industry, by enabling us better to explore the wealth buried in the bowels of the earth; Botany makes us acquainted with the plants, so varied and so beautiful, which supply our wants in magnificent prodigality; Zoology gives a knowledge of those animals which produce wool, silk, and honey, and those that assist us in our toils with their strength, as well as of those which, instead of being useful to us, destroy our crops. How important a guide natural history may be made to agriculture, the great pursuit in the United States! Besides, let us remember the long list of diseases by which the human machine is afflicted, and bear in mind the fact that the practice of medicine is blind in action when it does not rest on a scientific knowledge of the nature of man.

The practical importance of the study of natural history, we repeat, requires no proof, and must be felt, no matter what may be our career. But its influence does not stop here; the influence it can be made to exert over our faculties themselves, is worthy of the most serious attention. In fact, the natural sciences, by reason of the routine system peculiar to them, accustom the mind to go back from effects to causes, and at the same time invariably submit results deduced from preceding observations to the test of new facts; their study leads to speculations of the most elevated character, but never leads the imagination astray, because it always places material proof alongside of theory. And beyond any other pursuit, natural history exercises the mind in habits of *method*, a part of logic without which every investigation is laborious, and every exposition obscure.

Natural History ought to constitute one of the elements of every system of liberal education; but it is not necessary that every young man should be a naturalist. To become a proficient in a science so vast in its scope, would require more time than can be spared from other classical studies, and it comprises a host of details useful only to those who are desirous of devoting themselves especially to it. What every well-educated young man ought to know is, not the characteristics which distinguish this or that genus of plants or animals from another genus, nor the exact course of every nerve, or every artery in the human body: to charge his memory with such details, would subject him to labour which would be neither useful nor durable in its results; but what he ought to possess, are sound views on all the great questions that it is the province of the natural sciences to solve; those on the constitution of the earth, and the physical revolutions that have taken place on its surface; on the manner in which the functions of all creatures are performed, and the principal modifications observed in their structure, according to the kind of life for which they have been destined. Such information once acquired, would not be soon forgotten; and such information must be specially sought by all who would become naturalists; it is enough, however, for those whose occupations are not closely connected with these sciences.

Such are the opinions of M. Edwards, the eminent French naturalist. I am sure the propagation of these opinions in our country will advance its interests. To the science of agriculture, natural history, properly taught, is of great importance, because it teaches us the structure of animals, the mode of their existence, and what is essential to their life. This knowledge enables us to treat their diseases with a better prospect of success, and to destroy those animals which are injurious to our interests. Of the value of geology in teaching us the nature of the earth's surface, there is not less doubt.

It ought not to be urged against the study of natural history, that it requires us to become familiar with hard words. Every branch of human knowledge—every mechanic art, has its respective technicalities. Systematic names are only difficult to those who are unacquainted with their meaning. It has been observed by an eminent botanist of our country, Dr. Darlington, that ladies find no very great labour in acquiring a perfect knowledge of the technical language of fashion, of mantua-making and millinery. *Mousseline de laine, gros de Naples, gimp, gingham, gros des Indes, millenet, inserting, tetting*, &c. are examples of words which are hard to those who do not comprehend their meaning, but easy enough to those who understand their application. Morus multicaulis is a systematic name, which was for a time well understood by almost everybody in the United States.

And the same is true of the systematic names used in Natural History. Where there is a disposition to learn them, they are readily acquired at the cost of a little labour.

February, 1845.

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ELEMENTS OF ENTOMOLOGY.

THIRD BRANCH OF THE ANIMAL KINGDOM.

ARTICULATED ANIMALS.

LESSON I.

GENERAL CONSIDERATIONS.—*Structure of Articulated Animals—Division of the Third Branch of the Animal Kingdom.*
CLASS OF INSECTS.—*Organization — Metamorphosis — Classification.*

1. The third great division, or Third Branch of the Animal Kingdom, includes all animals that are constructed on the same general plan as insects. Their internal structure is essentially different from that of animals belonging to any of the other three branches of the animal kingdom; and their external characters are so decided and evident that it is almost always easy to recognise them at first sight.

2. They are termed articulated animals—*animalia articulata*—because their body is divided into sections, and seems to be composed of rings, placed in a contiguous series on a line with each other (*fig.* 1). The extremities in many instances are also formed in this manner. These rings are formed of portions of

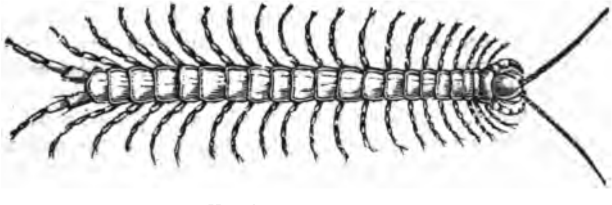

Fig. 1.—SCOLOPENDRA.

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1. What description of animals are comprised in the third branch of the animal kingdom?

2. Why are they termed articulated animals? How are the rings formed? Have articulated animals any skeleton?

skin which are harder and thicker than the rest of the body. In some cases this annular arrangement arises solely from the existence of a certain number of transverse folds or plaits which groove the skin and encircle the body; but in most instances the animal is enclosed in a species of solid armour, composed of a series of rings united to each other in such a manner as to permit of motion. The uses of this armour are similar to those of the internal frame or skeleton of vertebrate animals; because it determines the general form of the body, protects the soft parts, affords points of attachment for muscles, and furnishes them levers, fitted to secure precision and rapidity of motion. It is frequently termed an ***external skeleton***, although it does not represent our skeleton. In reality it is only the skin which has become hard and stiff. Its rings are of a horny consistence; and in some instances, they become almost, if not entirely, stony, forming a case in which the soft parts of the animal are enclosed.

3. In general, the rings of which this external skeleton is formed are movable upon each other, but in certain parts of the body, we sometimes see them soldered together, and then they are less easily distinguishable: this is always the case in the thorax of insects, but in other articulate animals, the centipedes or scolopendræ, for example, the rings are movable and like each other throughout the whole length of the body.

4. Some articulated animals have no extremities, an example of which we have in the common leech; but most of these animals are provided with them; the number of these extremities is very considerable; there are never less than three pairs, and sometimes we find several hundred, as in some marine annelidans.

5. The nervous system of articulated animals is always composed of a series of small ganglia attached together in pairs, placed upon the middle line of the inferior face of the body, and united by longitudinal cords of communication, so as to form a sort of chain, or, rather, to represent a double-knotted cord, extending from one end of the body to the other. The nervous mass formed by the first ganglion (*fig.* 2, *a*), which is sometimes called the ***brain***, is enclosed in the head, and is placed above and in front of the œsophagus; the other ganglia, on the contrary, are situate behind the œsophagus and beneath the digestive canal, so that the cords which unite the ganglia of the head to those of the thorax, pass from each side of the œsophagus and form

---

3 Are all the rings of articulated animals movable?

4. What is the number of extremities possessed by articulated animals?

5 What is the character of the nervous system in articulated animals? Have these animals a brain, properly so called?

around this canal a sort of collar (*d*). The different nerves of the body arise from these ganglia and ramify in the neighbouring parts.

6. The organs of the senses are less numerous than in vertebrate animals, and sometimes they are altogether wanting. In general they have eyes, and sometimes an apparatus of hearing, but no articulated animal has yet been discovered possessing a *distinct organ* of smell. It must not be inferred, however, from this fact, that they are all incapable of appreciating odours.

7. The digestive tube or canal of these animals is always extended from one end of the body to the other (*figs.* 12 and 74), and the mouth is generally furnished with jaws; but these organs do not move up and down as in vertebrate animals; they are always lateral, and move from without inwards.

8. In general their blood is white, but not always; in the class of anne'lida it is red; and its manner of circulating is various. In these animals the mode of respiration is equally various. They are all ovi'parous, that is, their young are produced from eggs.

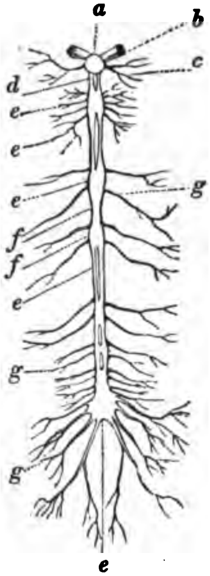

Fig. 2.—NERVES OF AN INSECT.

9. Articulated animals, possessing, as they do, a nervous system more developed than that of the mollusks, limbs for locomotion, and a sort of tegumentary skeleton, must necessarily be superior to them in every thing which essentially characterizes *animality*, that is, in the functions of relation; but, as respects the functions of vegetative life, they are not so well provided; their

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Explanation of Fig. 2.—The nervous system of an insect:—*a*, the brain or cephalic ganglion:—*b*, the optic nerves;—*c*, nerves of the head;—*d*, nervous cords which unite the brain to the thoracic ganglia, and form a collar around the œsophagus;—*e*, *e*, *e*, *e*, thoracic and abdominal ganglia;—*f*, nervous cords which unite the nerves with each other;—*g*, *g*, nerves of different parts of the body.

---

6. Are the senses perfect and complete? Have articulated animals the *sense* of smell?

7. What is the character of the digestive apparatus in articulated animals?

8. What is the colour of their blood? How do they breathe? How are they propagated?

9. In what respects are articulated animals superior to mollusks?

circulatory apparatus is less complete, and in some cases is altogether absent.

10. In a word, we see that articulated animals are chiefly distinguished from the other three branches of the animal kingdom by the arrangement of the nervous system and by the body being surrounded by a series of rings which seem to divide it into so many transverse segments.

11. This great branch of the animal kingdom is composed of six distinct classes of animals; namely, *insects*, *my'riapods*, *arach'nidans*, *crusta'ceans*, *cirr'hopods*, and *anne'lidans*. The following table exhibits some of the characters by which they are distinguished from each other.

				CLASSES.
ARTICULATED ANIMALS.	Blood white; provided with	lungs, or tracheæ for breathing air. Extremities articulated.	A distinct head, thorax and abdomen; three pairs of legs, and generally provided with wings. Tracheæ: but no circulatory apparatus properly so called.	INSE'CTA.
			Head, thorax, and abdomen, not separated from each other. Legs, twenty-four or more pairs. Tracheæ: no circulatory apparatus: without wings.	MYRI'APODA.
			Head confounded with the thorax. Always without wings. Four pairs of legs. Tracheæ, or pulmonary sacs. Vascular system tolerably well developed.	ARACH'NIDA
		branchiæ for breathing water.	In general, five or seven pairs of articulated legs. A circulatory apparatus.	CRUSTA'CEA.
			No legs for locomotion. Always live attached to other bodies.	CIRR'HOPODA.
	Red or coloured blood. Unprovided with articulated extremities. Generally having branchiæ.			ANNE'LIDA.

---

10. How are articulated animals distinguished from the other three Branches of the animal kingdom?

11. Into what classes is the Branch of articulated animals divided?

12. By an examination of the preceding table we learn:—that animals of the class **Insecta** have articulated extremities, tracheæ for breathing air, white blood, but no circulatory apparatus properly so called. They generally have wings and three pairs of legs. The head is distinct from the thorax:—

13. That animals of the class **Myri'apoda** have twenty-four or a greater number of pairs of articulated extremities; no wings; white blood, but no circulatory apparatus; and that they breathe by tracheæ. The head, thorax, and abdomen are confounded in an elongated body:—

14. That animals of the class **Arach'nida** have white blood, and generally a tolerably well developed vascular apparatus; tracheæ, or pulmonary sacs for breathing air; they have four pairs of articulated extremities, but are always destitute of wings. The head is confounded with the thorax:—

15. That animals of the class **Crusta'cea** have white blood; a circulatory apparatus; articulated extremities; five or seven pairs of legs, and branchiæ for breathing water;—

16. That animals of the class **Cirr'hopoda** have white blood, but no extremities for locomotion; and they always live attached to other bodies. They breathe water by means of branchiæ:—and, last,

17. That animals of the class **Anne'lida** have coloured blood; are unprovided with articulated extremities; and, in general, have branchiæ for breathing water.

CLASS OF INSECTS.

18. The class of insects includes all articulated animals that are unprovided with a circulatory apparatus properly so called, that breathe by tracheæ, undergo, in general, a metamorphosis while young, and possess six articulated extremities; they generally have wings, and the head, which is furnished with antennæ, is always distinct from the thorax.

---

12. What are the distinguishing characters of insects.

13. How are myri'apods characterized? How are they distinguished from insects.

14. What are the characters of arach'nidans? What distinguishes them from insects?

15. How are crusta'ceans distinguished? How do they differ from cirr'hopods?

16. What are the characters of cirr'hopods? What distinguishes them from insects?

17. What are the characters of anne'lidans? How are they distinguished from myri'apods?

18. What are the general characters of animals composing the class of insects?

19. The skin of insects is in general very hard, and almost horny; it forms a kind of solid case, in the interior of which are placed the muscles, viscera, &c.; it fulfils the functions of an external skeleton, and is divided by a series of rings more or less considerable in number.

20. The body is divided into three perfectly distinct parts; namely, head, thorax, and abdomen.

21. The *head* (*a*, *fig.* 3) is not subdivided into rings: it sustains the mouth, and two little stems or articulated horns, called *antennæ*, or feelers (*c*). These little organs are probably the seat of the sense of touch; their length and form vary very much; sometimes they are filiform, at others like a saw, club-shaped, &c.

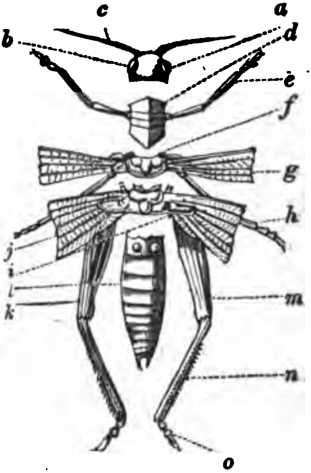

Fig. 3.—ANATOMY OF AN INSECT.

The surface of the head is sometimes divided into regions; namely, the *clypeus* (Latin, buckler), that part to which the labrum or upper lip is attached; the *face*, the *front*, the *vertex* or *summit*, and the *cheeks*.

22. The *thorax* (*d*, *f*, *i*, *fig.* 3), or middle portion of the body, is sometimes called the *corselet*, although this name, strictly speaking, belongs only to the second ring of the thorax, which, in all insects, is composed of three rings or segments, each one

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Explanation of Fig. 3.—Anatomy of the tegumentary system of a winged insect (a grasshopper):—*a*, the head;—*b*, the eyes;—*c*, the antennæ;—*d*, the prothorax, or first ring of the thorax;—*e*, the first pair of legs;—*f*, the mesothorax, or second ring of the thorax, bearing the first pair of wings (*g*), and the second pair of legs (*h*);—*i*, the metathorax, or third ring of the thorax, bearing the second pair of wings (*j*), and the third pair of legs (*k*);—*l*, the abdomen;—*m*, the femur or thigh;—*n*, the tibia or leg;—*o*, the tarsus or foot.

---

19. What purposes does the skin of insects fulfil?

20. How is the body of insects divided?

21. Is the head divided into rings? What parts are attached to the head?

22. To what part of the thorax does the name *corselet* particularly belong? Of how many pieces is the thorax composed? To what parts are the legs and wings of insects attached?

having a pair of legs attached to it. The first ring of the thorax (*d*) never has wings attached to it, and is always visible, while the succeeding rings are commonly covered above by these organs. When there are four wings, which is almost always the case, those of the first pair are attached to the second ring of the thorax (*f*), and are covered by the next pair, which are inserted into the sides of the third thora'cic ring (*i*). When there is only one pair of wings (as in the common fly), they are attached to the second ring of the thorax (*f*).

The first ring of the thorax (*d*) is called the ***prothorax*** (from the Greek, ***pro***, before, and ***thorax***, shield, or chest); the second ring (*f*), ***mesothorax*** (from the Greek, ***mesos***, the middle, and ***thorax***); and the third (*i*) the ***metathorax*** (from the Greek, ***meta***, between, and ***thorax***).

These three rings are closely and solidly united into one piece, and constitute the trunk, the inferior surface of which is styled the ***pectus***; that portion of it which corresponds to the ***prothorax***, is called ***ante-pectus*** (from the Latin, ***ante***, before, and ***pectus***, breast); that portion which corresponds to the ***mesothorax***, is called ***medio-pectus*** (from the Latin, ***medius***, the middle, and ***pectus***, breast); and the part corresponding to the ***metathorax***, is named ***post-pectus*** (from the Latin, ***post***, behind, and ***pectus***, breast). The middle line of the inferior surface of the trunk is termed the ***sternum***, and is divided into three parts; the ***ante-sternum***, ***medio-sternum***, and ***post-sternum***.

23. In all true insects, or, as they are also denominated, ***hexapods*** (from the Greek, ***exa***, six, and ***pous***, foot—having six feet), the abdomen is very distinct from the thorax, and has no extremities, neither feet nor wings, attached to it: it is composed of a certain number of rings, and we often find at its termination, near the anus, various appendages, such as stings or borers. The last rings or an'nuli of the abdomen, in several females, form a retractile or always projecting ovipositor, of a more or less complicated structure, which acts as an auger.

24. The legs of insects, which are solid tubes containing the muscles by which they are moved, are always six in number; there are never fewer than six, and if in some instances we see but four at first (as in certain butterflies, *Papilio*), we shall find on close examination that two of these organs are not developed, but are concealed under the hair.

25. Sometimes the legs are formed solely for walking; sometimes they are elongated and fitted for leaping, or they are spread out so as to constitute fins for swimming; and, again, they are modified in such a manner as to form organs of prehension.

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23. What extremities are attached to the abdomen?

24. What is the invariable number of legs in insects? Where are the muscles placed which move the legs?

25. Are the legs of all insects alike? What are the uses to which they are applied?

26. The leg is divided into four parts; the *coxa*, the *femur* or thigh, the *tibia* or leg, and *tarsus* or foot. The *coxa* (hip or haunch), which may be said to be set into the thorax, is formed of two pieces, and varies much in form. The *femur* (thigh, *m*, *fig*. 3) constitutes the second articulation of the leg; it is always tolerably long, and is sometimes remarkable for its development. The *tibia* (leg, *fig*. 3, *n*) is next to the *femur*, which it ordinarily equals in length; the whole extremity is terminated by the *tarsus* (*o*), which is almost always formed of from two to five articulations, and frequently bears at the end, one or more hooks or nails.

"In the generality of terrestrial insects, the last segment of the *tarsus* or foot is provided with a pair of strong horny hooks, which are available for many purposes, being used either for creeping upon a moderately rough surface, for climbing or clinging to various substances.

"Such simple hooks, however, would not always serve. In the case of the louse (*pediculus*), for example, that is destined to climb slender and polished hairs, such prehensile organs would be of little use. The structure of the foot is therefore modified; the tarsus in this insect terminates in a single movable claw, which bends back upon a tooth-like process derived from the tibia, and thus forms a pair of forceps fitted to grasp the stem of the hair and secure a firm hold.

"Many insects, especially those of the *dip'terous* order, are able to ascend the smoothest perpendicular planes, or even to run with facility, suspended by their feet, in an inverted position, along substances which, from their polished surfaces, could afford no hold to any apparatus of forceps or hooklets. In the common flies (*Muscidæ*) the exercise of this faculty is of such every-day occurrence, that, wonderful as it is, it scarcely attracts the attention of ordinary observers. The foot of the house-fly, nevertheless, is a very curious piece of mechanism; for in addition to the recurved hooks possessed by other climbing species, it is furnished with a pair of minute membranous flaps, which, under a good microscope, are seen to be covered with innumerable hairs of the utmost delicacy: these flaps, or suckers, as they might be termed, adhere to any plane surface with sufficient tenacity to support the whole weight of the fly, and thus confer upon it a power of progression denied to insects of ordinary construction.

"Another mode of progression common among insects is by leaping, to which from their extraordinary muscular power they are admirably adapted. The common flea, for example, will leap two hundred times its own length.

"The muscular system of insects has always excited the wonder and astonishment of the naturalist, in whatever point of view he examines this part of their economy, whether he considers the perfection of their movements, the inconceivable minuteness of the parts moved, or the strength, persistence, or velocity of their contractions. Insects are proverbially of small comparative dimensions—'minims of nature'—

———— that wave their limber fans
For wings, and smallest lineaments exact,
In all the liveries deck'd of summer's pride;'

their presence, indeed, around us, is only remarked as conferring additional life and gayety to the landscape; and except when, by some inordinate

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26. How is the leg divided? What is the coxa? What is the femur? What is the tibia? What is the tarsus?

increase of their numbers, they make up by their multitude for their diminutive size, the ravages committed by them are trifling and insignificant. Far otherwise, however, would it be, if they attained to larger growth, and still possessed the extraordinary power with which they are now so conspicuously gifted; they would then, indeed, become truly the tyrants of creation,—monsters such 'as fables never feigned, nor fear conceived,'—fully adequate to destroy and exterminate from the surface of the earth all that it contains of vegetable or of animal life.

"The flea or grasshopper will spring two hundred times its own length; the dragon-fly possesses such indomitable strength of wing, that for a day together it will sustain itself in the air, and fly with equal facility and swiftness backwards or forwards, to the right or to the left without turning; the beetles are encased in a dense and hard integument, impervious to ordinary violence; and we might add, that the wasp and the termite ant will penetrate with their jaws the hardest wood. Neither is the velocity of the movements of insects inferior to their prodigious muscular power. 'An anonymous writer in Nicholson's Journal,' say Kirby and Spence, 'calculates that in its ordinary flight the common house-fly (*Musca domestica*) makes with its wings about six hundred strokes, which carry it five feet, every second; but if alarmed, he states their velocity can be increased six or seven fold, or to thirty or thirty-five feet in the same period. In this space of time a race-horse could clear only ninety feet, which is at the rate of more than a mile in a minute. Our little fly, in her swiftest flight, will in the same space of time go more than the third of a mile. Now, compare the infinite difference of the size of the two animals (ten millions of the fly would hardly counterpoise one racer), and how wonderful will the velocity of this minute creature appear! Did the fly equal the race-horse in size, and retain its present powers in the ratio of its magnitude, it would traverse the globe with the rapidity of lightning.' "—*T. Rymer Jones.*

27. The wings are dry, membranous, elastic appendages, usually diaphanous, attached to the sides of the back of the thorax. They are composed of two thin membranes, laid one on the other, joined together by horny lines called *nervures*, which are in fact so many tracheal tubes for the passage of a r.

28. The wings of insects differ much in texture: in place of being *membranous* and *transparent*, as in flies and bees, they are sometimes *opaque* and covered by a multitude of little scales like dust, as in butterflies; and at other times we observe them acquire a thickness and consistence so great that they resemble horn, and do not differ from other hard parts of the insect, as in the may-bug, for example. It is only the first pair of wings that present this latter condition; when thus modified they are not suitable for flight, but form a species of shield for the protection of the upper part of the body, and are named *elytra*. Sometimes the *elytra*, instead of being horny throughout their whole extent, are membranous towards the end, as in wood-bugs: they are then called *demi-elytra*.

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27. What are wings? What are nervures?

28. In what respects do wings differ from each other? What are elytra? What are demi-elytra.

29. In some di'pterous insects, in place of the second pair of wings we find two pedunculated globular bodies, named *halteres*, or poisers.

30. The *eyes of insects* are always on a level with the head, and are never borne on a movable peduncle, as in certain crustaceans; sometimes their structure is the same as in ara'chnidans, and they are called simple eyes, or *ocelli;* but in all insects there exist, either conjointly with them or separately, ***compound eyes***, or *eyes with facets.*

"The compound eyes of insects are two in number, situated on the lateral aspects of the head, the form of each being more or less hemispherical. When examined with a microscope, their surface is seen to be divided into a multitude of hexagonal facets, between which minute hairs are generally conspicuous. The number of facets, or corneæ, for such in fact they are, varies in different genera: thus, in the ant (*For'mica*) there are 50; in the common house-fly (*Musca domestica*) 4,000; in some dragon-flies (*Libellula*) upwards of 12,000. In butterflies (*Papilio*) 17,355 have been counted, and some Coleopteræ possess the astonishing number of 25,088 distinct corneæ."—*T. Rymer Jones.*

31. Of the organs of smell and of hearing in these animals, we know nothing. The nervous system is composed of a chain of double ganglia, arranged as has already been described (*fig.* 2, *page* 11).

32. The mouth is placed in the anterior and inferior part of the head; but its form varies considerably, accordingly as the animal is destined to feed on solid or liquid substances.

33. In the *Tritores*, or triturating insects, the mouth is composed, 1st, of an upper lip; 2d, of a pair of mandibles; 3d, of a pair of jaws; and 4th, of a lower lip.

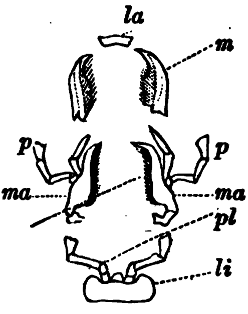

Fig. 4.—MOUTH OF AN INSECT.

Explanation of Fig. 4.—Apparatus of mastication of a coleo'pterous insect;—*la*, the labrum; — *m*, the mandibles; — *ma*, the maxillæ or jaws;—*p*, maxillary palpi;—*li*, the labium, or lower lip;—*pl*, the palpi of the labium.

29. What are halteres?
30. How are the eyes of insects situated? How many kinds of eyes have insects? What are compound eyes?
31. Where are the organs of smell and of hearing situated? How is the nervous system of insects arranged?
32. What is the character of the mouth? Where is it situated?
33. Of what parts does the mouth, in triturating insects, consist?

34. The upper lip or *labrum* (*la*, *fig.* 4) is a flat piece fixed to the anterior part of the head, and closes the mouth from above.

35. The *mandibles* (*m*) are appendages, resembling large teeth, which are inserted into the sides of the head immediately below and behind the labrum; they are movable, and transverse, that is, they are placed, one to the left and the other to the right; they are generally very hard and of a horny consistence. They serve to divide the food. The mandibles of insects never have palpi attached to them.

35. The *maxillæ*, or *jaws* (*ma*), are also two in number, and are placed, one on the right and the other on the left, below and behind the mandibles. Each jaw has, on its external side, a little appendage formed of from four to six articulations, named *maxillary palpus* (*p*); sometimes there are two *palpi*. In orthoptera the extremity of the palpus is often terminated by two lobes; in this case the external one is called the *galea*.

37. The *lower lip*, or *labium* (*li*) closes the mouth from below, and resembles a second pair of jaws, ordinarily joined on their internal side, and in a great degree covered by a horny prolongation in the middle, termed the *mentum*, or *chin*; the *ligula* is another part of the labium. Each half of this lip supports a *palpus* (*pl*, *fig.* 4) which is smaller than those of the maxillæ, and consists of never more than four articulations.

38. The annexed figure (5) is a magnified representation of the head of a cockroach (*Blatta*), seen from the front. A careful examination of the figure will more fully explain the several parts of the mouth; — *a*, the antennæ; — *b*, the compound eyes; — *c*, the *ocelli* or simple eyes; — *d*, the *labrum*; — *e*, the mandibles; — *f*, the maxillæ or jaws; — *g*, the *ligula*; — *h*, the labial palpi; — *i*, maxillary palpi. The principal use of the palpi is to seize and hold food between the mandibles, while it is being divided.

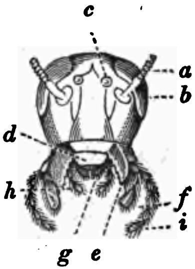

Fig. 5. — HEAD OF A COCKROACH.

Sometimes the jaws are enormously developed and form in front of the head a sort of pincers; an arrangement which is

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34. What is the labrum? Where is it attached?

35. What are mandibles in insects? How are they placed in respect to the labrum? What is their number? What is their use?

36. Where are the maxillæ placed? What is a maxillary palpus? What is meant by the *galea*?

37. What is the labium? What is the mentum? What is the ligula?

38. Of what use are the palpi?

very remarkable in the stag-beetles (*Lucanus cervus*) and other species of the genus lucanus; for example:

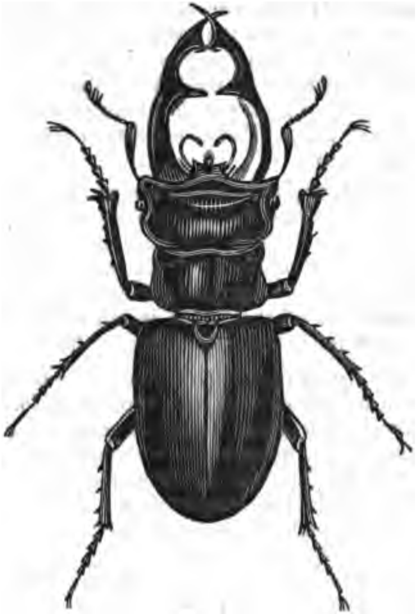

Fig. 6.—STAG BEETLE.

"The largest of these beetles in the New England States is the horn-bug. Its colour is a deep mahogany-brown; the upper jaws of the male are long, curved like a sickle, and furnished internally beyond the middle with a little tooth; those of the female are much shorter, and also toothed; the head of the male is broad and smooth, that of the other sex narrower and rough with punctures. The body of this beetle measures from one inch to an inch and a quarter, exclusive of the jaws. The time of its appearance in July and the beginning of August. The grubs (larvæ) live in the trunks and roots of various kinds of trees. Several other and smaller kinds of stag-beetles are found in New England."—*Harris.*

39. In insects that live by suction, the jaws or labrum are elongated in such a manner as to constitute a tubular trunk, in which we often find delicate filaments that perform the functions of little lancets; they are formed by the mandibles and jaws, so modified as to be scarcely remarkable.

40. In bees, the anthophoræ (from the Greek, *anthos*, flower, and *pherô*, I bear), and other insects known to zoologists

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39 What is the peculiarity of the mouth in insects that live by suction?
40. What are the peculiarities of the mouth in the Hymeno'ptera?

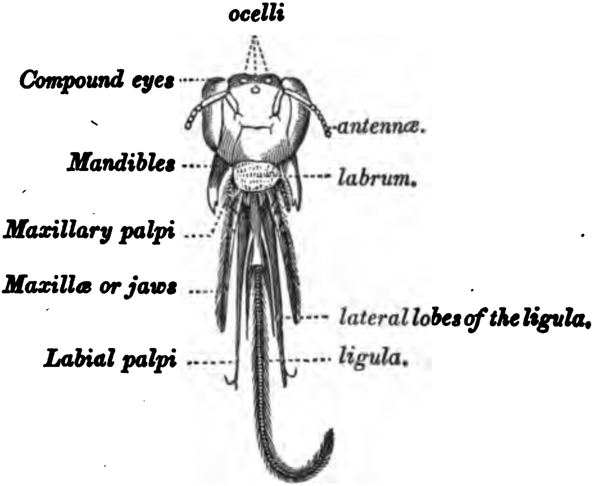

Fig. 7.—HEAD OF AN ANTHOPHORA.

under the common name of Hymenop'tera (from the Greek, *'umen*, a membrane, and *pteron*, a wing), the buccal apparatus has an intermediate arrangement. The upper lip or *labrum* (*fig.* 8, *a*) and the mandibles (*b*) closely resemble those of the *tritores* or triturating insects; but the jaws (*c*) and the ligula (*d*) are not excessively prolonged; the first take a tubular shape and form a longitudinal sheath for the sides of the ligula: so that these organs, joined in a packet, constitute a trunk, which conveys the food, always soft or liquid, upon which these animals feed. This trunk is movable at the base, and flexible throughout the rest of its extent, but never rolls itself up as we see in butterflies. The mandibles chiefly serve the purpose of dividing the materials of which the hymenopteræ make their nests, or rather, to seize and put to death the prey whose fluids these insects suck. There also exists in the interior of the buccal cavity other solid pieces which are wanting in the *Tritores;* they constitute valves destined to close the pharynx or swallow every time the movement of deglutition is not effected.

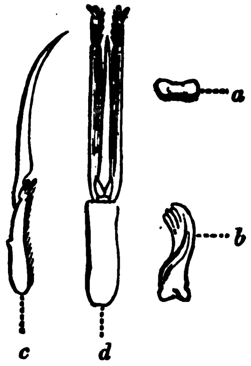

Fig. 8.

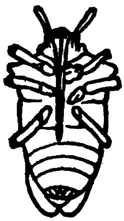

Fig. 9. — BUG.

41. In the bugs (*cimex*), plant lice (*aphis*), and other insects of the order Hemip'tera, the sucking apparatus is composed of the same elements, but somewhat differently arranged. The mouth is armed with a tubular and cylindical beak, directed downwards and backwards (*fig.* 9), and is composed of a sheath enclosing four stylets; the sheath (*fig.* 10, *a*) is formed of four articulations placed end to end, and represents the labium or lower lip; at its base we perceive an elongated, conical piece, which is analogous to the labrum; the stylets (*b*, *c*) which are in the form of fine threads, stiff and dentate at the extremity, to pierce the skin of animals or the substance of plants, are the representatives of the mandibles and maxillæ excessively elongated. In the hemip'teræ which live at the expense of other animals, the beak is generally very stout and folded in a semicircle under the head. In those that feed on the juices of plants, it is, on the contrary, almost always slender, and, when at rest, applied against the inferior surface of the thorax, betwixt the legs (*fig.* 9). Its length is sometimes so great as to extend beyond the posterior extremity of the abdomen.

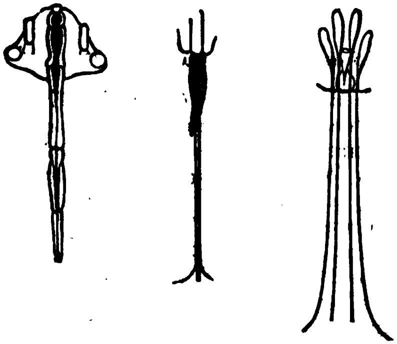

Fig. 10.—BUCCAL APPARATUS OF AN HEMIP'TERA.

42. In flies, the proboscis or trunk, sometimes soft and retractile, sometimes horny and elongated, also represents the labium or lower lip, and often has palpi at its base; a longitudinal groove on its upper surface lodges the stylets, which vary from two to six in number; the mandibles, jaws, and ligula of the tritores are analogous to them. Sometimes this trunk acquires an enormous length, and sometimes, on the contrary, it is scarcely visible.

43. In butterflies (*Papilio*) which also feed on the liquid substances they find at the bottom of flowers, and have no necessity for strong weapons to obtain them, there are no lancet-like stylets;

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41. How is the sucking apparatus in Hemiptera arranged?
42. What are the peculiarities of the sucking apparatus of flies?
43. Describe tne sucking apparatus of butterflies.

the mouth is furnished with a long trunk (*fig.* 11, *d*) rolled spirally, composed of two filaments hollowed into a gutter on the internal side, which are in fact the jaws excessively elongated and modified in form. At the base of this tube, we observe in front a small membranous piece which is the representative of the labrum, and, on each side, a small tubercle, the last vestiges of the mandibles. We also perceive in the same situation the rudiments of the maxillary palpi (*e*), and behind we find a little triangular lip bearing two very long labial palpi, composed of three articulations, almost always hairy and furnished with scales.

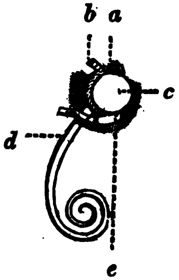

Fig. 11.—BEAK OF A BUTTERFLY.

44. The *digestive tube* (*fig.* 12) is always open at both ends, and extends from the mouth to the anus; sometimes it is straight, at others, more or less flexuous; and here, as in animals of a higher order, it is very short in carni'vorous insects, and very long in those species which feed on vegetable substances. Sometimes it preserves nearly the same diameter throughout its whole length; but, generally, it presents enlargements and contractions which enable us to distinguish an œsophagus, a stomach and an intestine. Sometimes we find several stomachs (*f*, *g*, *h*) which have been named, *crop*, *gizgard*, and *chyli'ferous ventricle*.

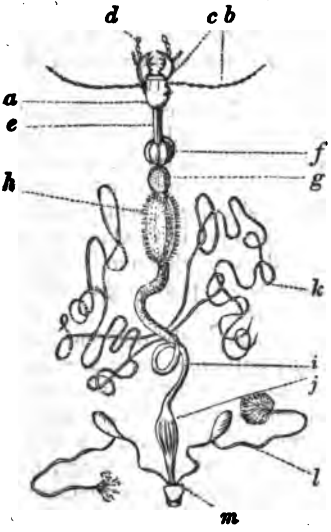

Fig. 12.—DIGESTION OF INSECTS.

45. On each side we see

Explanation of Fig. 11.—Beak of a butterfly;—*a*, the head;—*b*, antenna;—*c*, the eye;—*d*, proboscis or trunk spirally rolled;—*e*, rudiment of maxillary palpi.

Explanation of Fig. 12.—Digestive apparatus of an insect;—*a*, the head;—*b*, the antennæ;—*c*, the mandibles;—*d*, the palpi;—*e*, the œsophagus;—*f*, *g*, *h*, the stomachs;—*i*, the intestine;—*j*, the rectum;—*k*, the biliary vessels;—*l*, secreting organs;—*m*, the anus.

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44. What are the characters of the digestive organs in insects? For what is the digestive tube of carni'vorous insects remarkable? Of what parts do the digestive organs consist?

45. What are biliary vessels?

a number of long, delicate tubes, filled with a yellowish liquid, terminating in the digestive tube; these are the biliary vessels (*k*), which perform the functions of the liver.

46. We find salivary organs in a great many insects, and generally they are more developed in the suctorial than in the triturating species. They are simple, floating tubes, which sometimes terminate in a kind of utriculæ or little membranous sacs, which communicate with the pharynx by means of intermediate excretory ducts or canals.

47. Towards the posterior extremity of the intestinal canal, we also find other secreting organs of various forms (*l*) which serve for the elaboration of those particular liquids which many insects cause to exude from the posterior part of the abdomen when they are disturbed; the venom of the bee is an instance.

48. Sometimes the nutritive liquid resulting from the digestion of food is immediately appropriated to assimilation, sometimes, on the contrary, a part of it seems to be held in reserve to be employed on a future occasion. The species of reservoir which is regarded as subserving this curious purpose is the mass of fatty tissue surrounding the viscera.

49. Insects have no circulation properly so called; the nutritive liquid is diffused among all the organs and penetrates them by imbibition. But there exists, nevertheless, on the dorsal surface of the animal, immediately beneath the integuments, a sort of longitudinal tube, surrounded by fleshy fibres, which appears to be the rudiment of a heart, for we observe in it alternate contractions and dilatations similar to those of the same organ in other animals. But this canal does not appear to give off any branches; there are no arteries nor veins.

The blood, become venous by its action on the different tissues of the economy, is not carried to any particular point to come in contact with the oxygen of the air, to regain its vivifying qualities. If respiration were carried on in the ordinary way, by means of lungs or the external surface of the body, it would be extremely imperfect; but the disadvantage which seemingly must result from this great imperfection in so important a function as the circulation does not really exist. Nature has dispensed with the necessity of circulating the blood in insects, by carrying, the air in them, to all parts of the body, by means of a multitude of canals which ramify almost infinitely in the substance of the organs (*fig.* 13).

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46. What are the characters of salivary glands in insects?

47. Where is the venom of the bee formed?

48. Is digested food in all cases immediately appropriated to the purposes of assimilation?

49. How is the blood circulated in insects? How is the want of circulation compensated for in insects?

50. All insects have an aerial respiration; but instead of receiving air into pulmonary cavities to which the blood is sent by the action of the circulating organs, as is the case in most animals, they breathe by means of a multitude of canals (*fig.* 13) which convey the air to every part of the body; these canals are named *tracheæ.* The external openings of the tracheæ are called *stigmata* or spiracles. These openings have the form of a button-hole (*fig.* 14), and are placed on each side of the body. In this respect, the organization of tracheal ara'chnidans resembles that of insects.

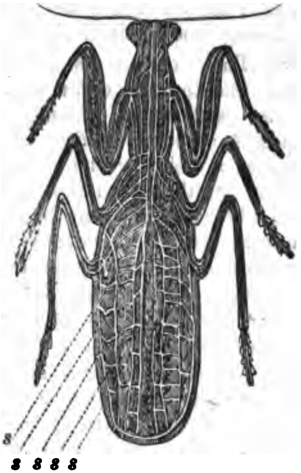

Fig. 13.—RESPIRATORY ORGANS.

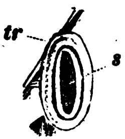

Fig. 14.
STIGMATA.

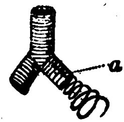

Fig. 15.
TRACHEA.

51. Sometimes the *tracheæ* have enlargements along their course like vesicles; they all communicate freely with each other; they are ramified like roots, and their last divisions penetrate into the substance of the organs. Their structure is the same as in tracheal ara'chnidans, that is, they are formed of a cartilaginous filament rolled spirally, so as to constitute a tube (*fig.* 15). Were it not for this arrangement the sides of the tube would be forced together by atmospheric pressure, and the animal would be suffocated for want of air. Respiration seems to be effected by the movements of the abdomen. In insects this function is very active: considering their size, they consume a considerable quantity of air, and quickly suffocate when deprived of

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Explanation of Fig. 13.—Respiratory apparatus of insects. The mask or covering of an insect, showing the principal tracheæ which convey air to all parts of the body;—*s*, *s*, *s*, *s*, *s*, the stigmata or spiracles.

Explanation of Fig. 14.—A stigmata magnified;—*s*, the opening of the stigmata or spiracle; *tr*, a tracheæ arising from it.

Explanation of Fig. 15.—A portion of tracheæ considerably enlarged to show its structure; we see at (*a*) the end of the spiral of which the tube is composed, partly unrolled.

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50. How do insects breathe? What are tracheæ? What are stigmata?

51. How are the tracheæ arranged? What is the peculiarity of their structure?

oxygen; but when they are seemingly dead from this cause, they for a long time retain the power of being restored to life.

52. The sexes are distinct in these animals, and frequently the males and females differ widely from each other. There frequently exists at the extremity of the abdomen of the female an ovipositor or borer or some other organ by means of which she prepares a hole for the reception of her eggs. Some are vivi'parous, but almost all insects lay eggs, but they do not deposit them wherever they may happen to be; they require them to be carefully lodged in some place where the young animals on escaping can readily obtain the kind of food proper for them. In this respect the instinct of insects is most surprisingly developed, and it would be interesting to study the various plans they adopt to secure this object, but our present limits will not permit.

53. When an insect escapes from its egg, it sometimes possesses the same form which it is to preserve through life; but in the great majority of instances, it differs more or less from its mother, as well as from the form it itself is destined to assume. Before attaining its perfect state, it undergoes considerable changes, which are designated under the name of *metamorphoses;* it passes through two successive conditions, termed the *larva* (Latin, a mask, because the perfect form of the insect is concealed as it were under a mask), and *nympha*, *pupa*, or *chry'salis* (from the Greek, *chrusos*, gold, because the transparent covering in which the animal is enclosed while in this state, in many instances reflects a metallic lustre). When it has passed through these two stages of its metamorphosis, it becomes a perfect insect, and is then called *imago*. But these changes are not always of the same nature; some insects experience only a partial metamorphosis, some a demi-metamorphosis, and others, a complete metamorphosis (from the Greek, *meta*, indicating change, and *morphe*, form).

54. Those insects which undergo *partial metamorphosis* acquire after birth a number of legs, more or less, but always remain without wings. The Parasi'ta and Thysanou'ra experience this description of metamorphosis.

55. Those insects which undergo *demi-metamorphosis* differ very little from what they are to become; their larva resembles

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52. How are the young of insects produced?

53. What is meant by the metamorphosis of an insect? What is a larva? What is a nympha? To what condition of insects are the terms *pupa* and *chrysalis* applied? What is an *imago*? Is the metamorphosis the same in extent in all insects?

54. What is meant by partial metamorphosis?

55. What is meant by demi-metamorphosis?

the perfect insect except that it is unprovided with wings. The annexed figure (16) of the larva of a grasshopper illustrates this condition. When it becomes a nympha, we discover that it has the stumps or rudiments of wings; at the last moult they become perfectly developed, and the insect then acquires the form it preserves through life.

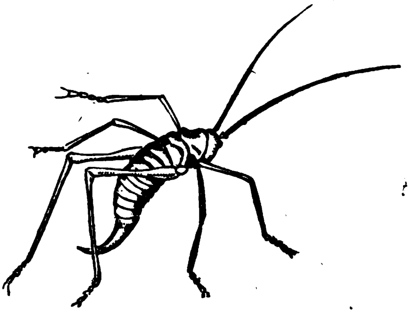
Fig. 16.—LARVA OF A GRASSHOPPER.

56. The *larva* of those insects which undergo *complete metamorphosis*, in no respect resembles the *imago* or perfect animal, and in proof of this it is only necessary to recollect that the *butterfly* escapes from its egg in the form of a *caterpillar*. Larvæ (*figs*. 17 and 18) are in general soft, cylindrical, or fusiform, presenting at intervals a number of contractions which divide the body into as many rings or segments. Sometimes they have the appearance of a worm, and are unprovided with legs, as in the larva of the bee; in other instances, they have appendages of this kind (*fig*. 18), and then they are generally called *caterpillars*. These animals have a head provided with jaws, several small eyes, very short legs, six of which are scaly and pointed, and attached to the three rings next to the head; they have also other legs, varying in number, which are membranous and attached to the last rings of the body. After having lived for a certain time in the larva state, the insect becomes transformed into a *nympha*, and is then motionless, and

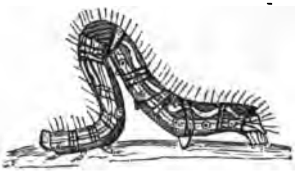
Fig. 17.—LARVA.—MEASURING WORM.

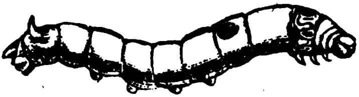
Fig. 18.—LARVA.—SILK-WORM.

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56. What are the general characters of larvæ? What are caterpillars? How does the larva prepare to become a nympha? What are *spinnarets?*

does not eat (*fig.* 19). Before undergoing this metamor'phosis, the larva often prepares for itself a defence or protection, and encloses itself in a shell or cocoon (*fig.* 20), which it makes of various materials; but more especially of the ***silk*** secreted by organs analogous to salivary glands, and spun by the assistance of ***spinnarets*** hollowed in the lips. The insect, in the state of a nympha, possesses all the parts of the perfect animal, but contracted and covered up, sometimes by a delicate pellicle through which they may be seen, giving the nympha the appearance of a bandaged mummy; sometimes by a pretty thick skin, which is moulded over the body; at other times, by the dried skin of the larva, which forms a sort of case or shell around the animal, presenting the form of an egg. Finally, after having remained in this state of immobility for a period varying in duration, the perfect insect (imago) escapes from the nympha, and the external organs, at first humid and soft, are dried by the air and acquire the consistence they afterwards maintain. These changes in the external form of the insect at different periods of its life are accompanied by modifications, not less remarkable, in the internal structure of the animal; and these changes of organization induce others in the habits of these creatures as well as in the manner of feeding.

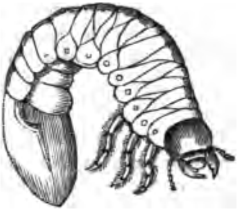
Fig. 19.—NYMPHA.

Fig. 20.
NYMPHA.

57. The number of insects is immense; it is estimated that it exceeds sixty thousand species, and they differ very much from each other both in their external form and manner of living.

Insects, so remarkable for their organization, are still more so for their habits and for the admirable instinct with which nature has endowed a great number of them. Their cunning plans for procuring food or for escaping their enemies, and the industry they display in their works, surprise all who witness them; and when we see them united in societies to gain the power denied to their individual feebleness, aiding each other, dividing the toils necessary for the prosperity of the community, providing for their future wants, and frequently regulating their actions accord-

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Explanation of **Fig. 20.—A nympha with one-half of its shell or cocoon removed.**

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57. What is the number of insects known?

ing to accidental circumstances, we are astounded to find in these creatures, so small and apparently so imperfect, instincts so varied and so powerful, and intellectual combinations which so closely resemble reasoning.

58. The division of this class into orders principally depends upon the form of the buccal apparatus, the organs of locomotion, and the metamorphosis.

The following table exhibits the principal characters of the several orders of the class of Insects:

						ORDERS.
INSECTS	have three pairs of legs and	undergo metamorphosis. Mouth formed for	mastication. Wings four; the two anterior	in form of elytra; those of the second pair	folded only transversely.	COLEO'PTERA.
					folded in two directions, or lengthwise only.	ORTHO'PTERA.
				Membranous and reticulated like the posterior.		NEURO'PTERA.
			suction. Wings	four,	All membranous, transparent and divided into large cells. Mouth armed with distinct mandibles.	HYMENO'PTERA.
					All covered by a kind of coloured dust. Mouth armed with a spiral trunk only.	LEPIDO'PTERA.
					The anterior ordinarily in form of demi-elytra. Mouth armed with a conical beak, either straight or curved.	HEMI'PTERA.
				two,	folded like a fan.	RHIPI'PTERA.
					Not folded.	DI'PTERA.
				entirely wanting		SUCTO'RIA.
		not subject to metamorphosis. No wings. Abdomen	unprovided with appendages.			PARASI'TA.
			provided with false legs, or appendages for leaping.			THYSANOU'RA.

☞ The Myriapods, which have twenty-four pairs of legs or more, and are without wings, now form a distinct class, and are not insects properly so called. They were formerly included among the apterous insects.

59. The *Thysanou'ra*, *Parasi'ta*, and *Sucto'ria*, have no wings, and for this reason are frequently spoken of under the common name of AP'TERA (from the Greek, *a*, without, and *pteron*, wing), or apterous insects. All other orders of insects have wings, and are spoken of by the common name of *winged insects*.

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58. How is the class of insects divided?
59. What is meant by the term apterous insects?

LESSON II.

AP'TERA.—ORDER OF THYSANOU'RA.
ORDER OF PARASI'TA.—*Louse—Ticks.*
ORDER OF SUCTO'RIA.—*Flea—Chigre.*
ORDER OF COLEOP'TERA.—*Characters—Division—Pentame'rans Cicin'dela—Carabus—Gyrinus, or Water-beetle—Fire-flies—Glow-worm—Borers—Derme'stes—May-bugs—Scarabeus—Heterome'rans—Blistering-flies—Teterame'rans—Weevils—Trime'rans—Lady-bug.*
ORDER OF ORTHO'PTERA.—*Characters—Earwigs—Mole-crickets—Crickets—Grasshoppers—Migratory Locusts.*

1. Hexapods or true insects comprise all those which have three pairs of legs: they all have a head distinct from the thorax, and the abdomen has no extremities attached to it; some are apterous (without wings), others are winged.

2. Although apterous insects are not very numerous, they form three distinct orders; namely, *Thysanou'ra*, *Parasi'ta*, and *Sucto'ria*.

ORDER OF THYSANOU'RA.

3. The Thysanouræ (from the Greek, *thusan*, bushy, and *oura*, tail) are small wingless insects that do not undergo metamorphosis; the abdomen terminates in filiform appendages, or is furnished with organs by means of which they are enabled to leap.

ORDER OF PARASI'TA.

4. We give the name of parasites (hanger on) to those apterous insects which do not undergo metamorphosis and whose abdomen is without any appendage; their mouth is chiefly internal and is armed with a kind of sucker; their body is flattened, and, as their name indicates, they live upon other animals; but they are only found on mammals and birds. Lice (*Pediculus*), of one of which the annexed figure (21) is an enlarged representation, and dog-ticks (*Ricinus*) belong to this order. Their eggs are known under the name of *nits*.

Fig. 21.
LOUSE.

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1. Do all insects possess wings?
2. What orders of insects are wingless?
3. What are thysanou'ra?
4. Give examples of insects of the order Parasita.

ORDER OF SUCTO'RIA.

5. Suctorial insects, like the preceding, are ap'terous, but they do not undergo metamorphosis. The body is very much compressed (*fig.* 22), and the hind legs are adapted to leaping. The mouth is extended in the form of a trunk or beak, which contains three bristle-like lancets, and performs the functions of a sucker. They undergo complete metamorphosis, and in the larva state, are in form of little worms without feet; in the imago or perfect state, they live on quadrupeds or birds.

This order comprises but a single genus, that of the *Fleas*.

6. The common flea—*Pulex irritans*—(*fig.* 22) lives upon dogs, cats, and men, whose blood it sucks. The chigre—*Pulex penetrans*—very common in the warm parts of America, is armed with a beak as long as its body. The female carries her eggs in a sack under the abdomen, and by its rapid growth, this part in a short time acquires the size of a small pea, while the animal itself is scarcely as large as a common flea. It insinuates itself beneath the skin, and into the flesh, particularly about the feet and toes, where it deposits its eggs, and sometimes causes great pain and ill-conditioned sores. The only remedy is to remove the sack of eggs with a needle, and fill the hole with strong mercurial ointment. This will be found effectual. It also attacks monkeys, dogs, &c.

Fig. 22.—FLEA.

ORDER OF COLEOP'TERA.

7. The order of Coleop'tera (from the Greek, *koleos*, a case, and *pteron*, wing) comprises insects which have a mouth armed with jaws, and four wings, differing from each other in texture. The first pair are horny elytra (from the Greek, *elutron*, a sheath), which are not suitable for flight, but constitute a covering or shield for the second pair, which are membranous, and when in a state of repose, folded transversely.

8. The tegumentary envelope of these insects is almost always remarkably hard, and sometimes forms a solid, and almost crustaceous cuirass. The mouth is formed for the mastication of food, and is armed with a pair of mandibles, a pair of maxillæ, bearing palpi, and a labium or lower lip, also bearing palpi (*fig.* 4). The wings possess peculiarities of structure which it is important to note: the first pair are of the same consistence as other

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5. How is the order Sucto'ria characterized?

6. What are chigres?

7. What are the characters of the order Coleop'tera?

8. What are the characters of the mouth of Coleop'tera? What is the nature of the wings? How is the abdomen attached to the thorax?

parts of the tegumentary skeleton, and form two sheaths or solid *elytra*, joined together by a straight edge, sometimes solidly united, forming a kind of shield over the abdomen (*figs.* 23 and 26). Sometimes these elytra are rudimentary, but are never entirely wanting in both sexes. The same is not true of the wings of the second pair, which are membranous, much larger than the elytra, and when in a state of repose, folded transversely at their extremity; sometimes they are wanting, and then the insect is incapable of flying. There is no peculiarity of the legs worthy of special remark. The abdomen is *sessile*, that is, it is broadest where it joins the thorax, and on each side of the rings which form it, there is, on the upper part, an opening, which is a stigmata.

9. The metamorphosis which the Coleop'teræ undergo after escaping from the egg is complete. The *larva* resembles a soft worm, the head of which as well as the three first rings of the body are scaly (*figs.* 4, 9, 19, and 25). They generally have three pairs of horny legs, terminating in a point. Sometimes there are no legs, or they are replaced by small fleshy tubercles; but we never find a greater number of these appendages. The mouth has the same organization as the perfect insect; the eyes, on the contrary, are merely represented by small granular bodies, which seem to consist of an assemblage of simple eyes, which never exist in adult Coleop'teræ; and we perceive on each side of the body nine stigmata arranged in a series.

10. The nympha is always inactive; sometimes it is enclosed in a shell or cocoon, generally composed of different substances joined together by a viscid, silky matter; sometimes it is naked. The duration of these changes and the mode of life, as well in the larva as in the perfect insect, vary in the different families of this order.

11. The number of Coleop'teræ is immense, and to distinguish them more readily they are divided into four sections, according to the number of articulations or joints of the tarsi; namely,

1st. The *Pentame'rans* (from the Greek, *pente*, five, and *meros*, a joint), in which the tarsus of all the legs is composed of five joints.

2d. The *Heterome'rans* (from the Greek, *'eteros*, various, and *meros*, joint), in which the tarsi have four articulations on the two fore legs, and five on the others.

3d. The *Teterame'rans* (from the Greek, *tetteres*, four, and *meros*, joint), in which the tarsi of all the legs have four articulations.

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9. What description of metamorphosis do the Coleop'teræ undergo?
10. What is the condition of the nymphæ of Coleop'teræ?
11. How is the order of Coleop'tera divided?

4th. The *Trime'rans* (from the Greek, *treis*, three, and *meros*, joint or part), in which all the tarsi have three articulations.

COLEOP'TEROUS PENTAME'RANS.

12. This division is composed of several families, among which are the *Carni'vora*, the *Ser'ricornes*, the *Cla'vicornes*, and the *Lame'llicornes*.

13. The family of *Carni'vora* (from the Latin, *caro*, in the genitive, *carnis*, flesh, and *voro*, I eat) is distinguished by having double palpi on the maxillæ. These insects pursue and devour others. Several have no wings under the wing-covers or elytra. The larvæ are also very carni'vorous. This family is one of the largest of the Coleop'tera, and contains a great many tribes and genera. Among them we shall mention the *Cicin'dela* (from the Latin, *cicendela*, a glow-worm), a genus of small insects, possessed of brilliant metallic colours, commonly met with in dry, sunny situations. They run with considerable swiftness, take wing the moment they are approached, but alight at a short distance. The larvæ excavate holes in the earth, and such is their voracity that they devour other larvæ of the same species, which have taken up their abode in the neighbourhood.

14. The *Carabi* — *Carabus* — which generally conceal themselves under stones or in the earth, one species of which, the *Carabus auratus* (*fig.* 23), is very common in the environs of Paris. It is about an inch long, and remarkable for the brilliance of its colours; it is golden green above and black below. All the Carabi are swift runners, and when they have wings, rarely make use of them. Most of them exhale a fetid odour, and when disturbed, they throw out from the mouth and anus a caustic or acrid liquid.

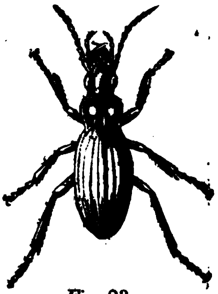
Fig. 23.
CARABUS AURATUS.

15. The genus *Gy'rinus* (from the Greek, *guros*, a circle) comprises aquatic insects that pass the greater part of their lives in the water, but they nevertheless are obliged to visit the surface to breathe. Their four anterior legs are in form of fins. They are often seen in numerous groups on the surface of stagnant pools; they swim with great velocity, forming circular tracks in various directions.

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12. How are coleop'terous Pentame'rans divided?
13. How is the family of Carni'vora distinguished?
14. What are the characters of the genus Carabus?
15. How is the genus Gy'rinus characterized?

The water-beetle (*Dytiscus*) is represented in the larva state (*fig.* 24), in the nympha state (*fig.* 25), in the imago or perfect insect (*fig.* 26).

Fig. 24.
LARVA.

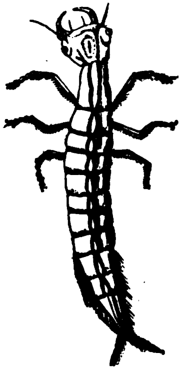

Fig. 25.—NYMPHA.

"Nothing is, perhaps, better calculated to excite the admiration of the student of animated nature, than the amazing results produced by the slightest deviations from a common type of organization; and in examining the changes required in order to metamorphose an organ which we have already seen performing such a variety of offices into fins adapted to an aquatic life, this circumstance must strike the mind of the most heedless observer. The limbs used in swimming exhibit the same parts, the same number of joints, and almost the same shape, as those employed for creeping, climbing, leaping, and numerous other purposes; yet how different is the function assigned to them! In the common water-beetle (*fig.* 26) the two anterior pairs of legs, that could be of small service as instruments of propulsion, are so small as to appear quite disproportionate to the size of the insect, while the hinder pair are of great size and strength; the last-mentioned limbs are, moreover, removed as far backwards as possible by the development of the hinder segment of the thorax, in order to approximate their origins to the centre of the body, and the individual segments composing them are broad and compressed, so as to present an extensive surface to the water, which is still further enlarged by the presence of flat spines, appended to the end of the tibia, as well as of a broad fringe of stiff hairs inserted all around the tarsus. The powerful oars thus formed can open until they form right angles with the axis of the body, and from the strength of their stroke are well adapted to the piratical habits of their possessors, who wage successful war, not only with other aquatic insects and worms, but even with small fishes, the co-inhabitants of the ponds wherein they live."—*T. Rymer Jones.*

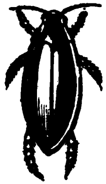

Fig. 26.
WATER-BEETLE.

16. Other coleop'terous Pentame'rans, which have but two palpi on the maxillæ, and filiform or saw-like antennæ, belong to the family of *Ser'ricornes* (from the Latin, *serra*, a saw, and *cornu*, horn), are worthy attention.

17. Of this number are the fire-flies—*Elater*—(from the Greek, *elater*, a leaper), which have the power of leaping when placed on the back. If a beetle be seen to fall upon its back, and instead of making the ordinary efforts to set itself on its legs, bends its

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16 How is the family of Ser'ricornes characterized?
17. What are the habits of fire-flies?

head towards its tail, raising this part, and repeating this action until it has fallen on its feet, such a beetle may be recognised at once as a species of *Elater*. These beetles are often found on flowers and on the grass: like many other coleop'terous insects, when approached they fall to the ground and feign to be dead. There is one species (*Elater noctilucus*) about an inch long, which inhabits South America, and has two brown spots on the corselet, which at night diffuse a light so bright that the Indians make use of them to light them in their nocturnal labours and excursions.

18. There is in the neighbourhood of Paris an insect, similar to the last in producing phosphorescent light, the *Lam'pyra* (from the Greek, *lampuros*, a glow-worm). The males (*fig.* 27) are not particularly remarkable; but the female (*fig.* 28), which is without wings, diffuses a phosphorescent light at night, which circumstance has obtained for it the common name of *glow-worm*. This light issues from the abdomen, and the animal can vary its intensity at pleasure. The females of the species of Lam'pyra inhabiting warm countries, are, on the contrary, all winged, and in flying through the air after sunset, they often produce a natural illumination comparable to numberless little moving stars.

Fig. 28.
GLOW-WORM.

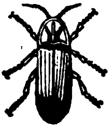
Fig. 27.
LAMPYRA.

19. We give the name of *borers* (*Ano'bium*) to small insects which inhabit our dwellings; while in the larva state they are very destructive, for then they eat the floors, joists, books, &c., through which they pierce little round holes similar to those made by a very fine gimlet; their excrements form those little pulve'rulent heaps of worm-eaten wood we often see on the floors of old houses. Another species of borer in the same manner eats farinaceous substances, and ravages collections of insects.

20. Insects of the family of *Cla'vicornes* (from the Latin, *clava*, a club, and *cornu*, horn) are characterized by antennæ in form of a club. To this family belong the *Derme'stes* (from the Greek, *derma*, skin, and *esthiô*, I eat). They have an oval body, and their larvæ, which feed on animal substances, commit great depredations in fur stores, and in museums of natural history. The Bacon-beetle belongs to this family.

21. We place in the family of *Lame'llicornes* (from the Latin,

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18. What are glow-worms?

19. What are the habits of borers?

20. How is the family of Cla'vicornes characterized? What are the characters of the Dermes'tes?

21. What are the characters of the Lame'llicornes?

Fig. 29.
HORNED BEETLE.

lamella, a little thin plate, and *cornu*, horn) may-bugs —*Melolontha*, — dung-beetles — *Copris* (from the Greek, *kopros*, dung), — beetles —*Scarabeus*,—and many other coleop'terous Pentame'rans which have the antennæ terminated by a packet of lamellæ arranged like a fan or the leaves of a book (*fig*. 29). They all have wings, and walk slowly; their body is oval, and their larvæ are very injurious to agriculture from their eating the roots of plants.

22. The larva of the common May-bug or May-chaffer (*Melolontha vulgaris*), which belongs to the tribe of Cut-worms, is one of the most destructive (*fig*. 30). It lives three or four years without undergoing metamorphosis, and during the whole time remains more or less profoundly buried in the earth; in winter it falls into a kind of lethargy and takes no food. This insect finishes its metamorphosis about the month of February; but it is then very soft, and does not reach the surface of the ground till towards March or April, and leaves it about the beginning of May. In the perfect state, May-bugs feed on leaves, and they are sometimes so numerous as to strip a forest in a short time. During the day they commonly remain at rest, but fly at night; their flight is heavy and noisy, and their course is directed so badly that they strike against every thing that comes in their way.

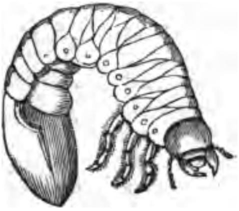

Fig. 30.
LARVA OF MAY-BUG.

The species of beetle or *scarabeus*, so frequently represented by the Egyptians, either on their monuments or sculptured stones, which seems to have been used by them as a hieroglyphic, an amulet, and even as an object of religious worship, is of the family of Lame'llicornes, and belongs to the genus Ateuchus.

COLEOP'TEROUS HETEROME'RANS.

23. The section of *Coleop'terous Heterome'rans* also embraces very interesting insects, not on account of the ravages they cause, but on account of their great utility in medicine. We refer especially to the *Cantha'rides*. These little insects contain a peculiar irritating matter, which, when applied to the skin, has

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22. What are the habits of the larvæ of the May-bug?
23. What are Spanish flies?

the property of producing a blister. The species employed in medicine is the *Cantharis vesicatoria*, commonly called the *Spanish fly*. The body is about half an inch in length, and the elytra are long, flexible, and of a brilliant golden green colour; it is very common in Spain, Italy, France, and Russia, where it lives in great numbers, on the ash, the lily, privet, &c. The *potatoe fly*, *Cantharis vitata*, is an American species, which possesses qualities similar to the European.

COLEOP'TEROUS TETRAME'RANS.

24. Among the *Coleop'terous Tetrame'rans* we place *Weevils*, which may be readily recognised by having a head elongated in a kind of snout or trunk, upon which are placed the antennæ. These insects are gnawers and feed on vegetable substances; the larvæ, which are without legs, frequently cause a great deal of damage by attacking wheat.

"Would it be believed," says Wilson, the ornithologist, "that the larvæ of an insect, or fly, no larger than a grain of rice, should, silently, and in one season, destroy some thousand acres of pine trees, many of them two or three feet in diameter, and one hundred and fifty feet high. Yet, whoever passes along the high road from Georgetown to Charleston, in South Carolina, about twenty miles from the former place, can have striking and melancholy proofs of the fact. In some places, the whole woods, as far as you can see around you, are dead, stripped of the bark, their wintry looking arms and bare trunks bleaching in the sun and tumbling in ruins before every blast, presenting a frightful picture of desolation. Until some effectual preventive or more complete remedy can be devised against these insects and their larvæ, I would humbly suggest the propriety of protecting, and receiving with proper feelings of gratitude, the services of this and the whole tribe of woodpeckers, letting the odium of guilt rest on its proper owners."

COLEOP'TEROUS TRIME'RANS.

25. As an example of *Coleop'terous Trime'rans*, we mention the *lady-bug*—*Coccin'ella* (from the Latin, *coccinus*, crimson)—so common in our gardens. These beetles are of great service to the agriculturist, and especially to the hop-grower; for they destroy the plant-lice (*aphides*), in vast numbers feeding on them both in the larva and perfect state.

ORDER OF ORTHOP'TERA.

26. Insects of the order of *Orthop'tera* (from the Greek, *orthos*, straight, and *pteron*, wing) are distinguished,

1st. By having the mouth armed with mandibles and maxillæ arranged for mastication.

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24. How are Weevils characterized?
25. To what division of the Coleop'tera does the lady-bug belong?
26. How is the order of Orthop'tera distinguished?

2d. By having four wings, the two anterior of which constitute the elytra or wing-cases, and the two posterior are membranous and folded longitudinally when in repose, as in the grasshopper.

27. The body of these insects is less consistent generally than that of the Coleop'teræ, and is elongated in form, as for example, in the mole-cricket, domestic cricket, and grasshopper. In most insects of this order the head is large and vertical. The elytra slightly cross each other, and are almost always coria'ceous, flexible, and reticulated; their position varies; but in a great many instances they are placed obliquely or tile-like. The same is the case with the wings, which are broad and sometimes folded transversely, as well as lengthwise. Sometimes all the legs are of the same size and shape; sometimes on the contrary they are dissimilar. Sometimes the first pair of legs differ in form from the others, and are adapted for digging in the ground or for seizing their prey; at other times the hind legs are very much developed and constitute leaping organs; in all cases the last articulation of the tarsus is terminated by two hooks. The abdomen, the form of which is usually elongated, in a great many females has appendages attached to its posterior extremity, constituting a borer or *ovipositor*, by means of which these insects introduce their eggs into holes which serve their young for nests. The Orthop'teræ undergo *demi-metamorphosis*, and the only changes they experience consist in the development of elytra and wings; in other respects the larva and nympha resemble the perfect insect.

28. All the insects of this order are terrestrial, and most of them feed on living plants; they are very voracious, and sometimes commit great havoc.

Among the most interesting of the Orthop'teræ are the ear-wigs, mole-crickets, crickets, grasshoppers, and locusts.

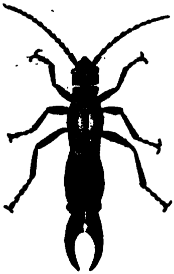

Fig. 31.—EAR-WIG.

29. The *Ear-wigs* (*fig*. 31)—*Forfi'cula* (from the Latin, *forfex*, pincers)—have a linear body, very short elytra, and the abdomen is terminated by two horny movable appendages resembling pincers. These insects are very common in damp grounds; they sometimes assemble in large numbers, and are very destructive to fruit trees. It was believed that they insinuated themselves into the ear, and to this popular opinion is due their common name; but it is an error, for they only raise the pincers that terminate the abdomen in self-defence.

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27. What are the characters of the Orthop'teræ?
28. What are the habits of Orthop'teræ?
29. How are ear-wigs characterized? Are they dangerous?

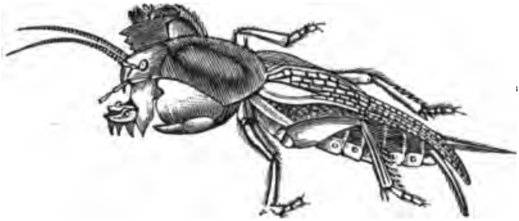

Fig. 32. — MOLE-CRICKET.

30. The *Mole-crickets—Grillo-talpa* (*fig.* 32)—have broad, flat fore legs, adapted for digging; the *common Mole-cricket* (*Grillo-talpa vulgaris*) lives in the ground, and is very injurious from its habit of digging subterraneous passages like moles, and cutting or detaching the roots of all plants that come in its way.

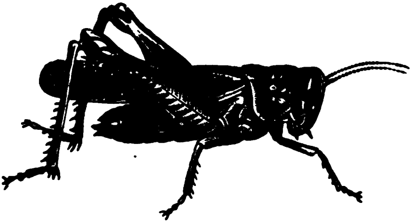

Fig. 33.—CRICKET.

31. The *Crickets — Gryllus* (*fig.* 33) — resemble the mole-cricket, but their fore legs are not formed for digging, although some of them dig holes. The domestic cricket (*Gryllus domesticus*) inhabits dwellings, and usually seeks the warmth of the chimney. Crickets leap almost as well as grasshoppers, and are not unlike them. Male crickets produce that sharp sound, commonly called their song, by rubbing their thighs against the wings.

32. Grasshoppers (*figs.* 34 and 35) closely resemble crickets· but their tarsi have four articulations, and their antennæ are long and consist of numerous small articulations. Like crickets, their hind legs are formed for leaping; they walk slowly, but fly well. The females deposit their eggs in the ground by means of the

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30. What are the characters of mole-crickets?

31. How are crickets characterized? What are their habits? How is their song produced?

32. How are grasshoppers characterized? What are migratory locusts?

sword-like ovipositor, which terminates the abdomen. The larvæ have neither wings nor sheaths for containing them; in other respects they resemble the imago or perfect insect. The genus *Acry'dium* belongs to this group. These last Orthop'teræ have on each side of the first ring of the abdomen a kind of membranous drum, by means of which they produce a sound, improperly called their song. They are very common in fields; they frequently assemble in countless multitudes, commonly known as *Migratory locusts*, and in this way travel great distances; the passage of one of these destructive bands sometimes converts a whole kingdom into a desert, in a very short period. This scourge is more frequent in Africa, but the same species of locust also shows itself in Europe. In certain countries of Africa, these insects are eaten; certain Asiatics, after drying and grinding them, make them into bread. At Bagdad they are sold in the market.

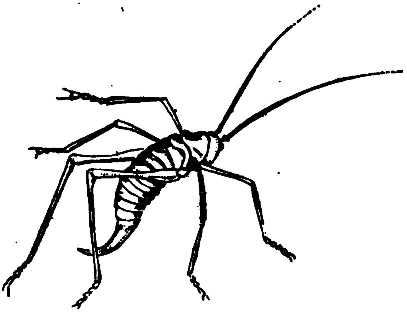

Fig. 34.—LARVA OF GRASSHOPPER.

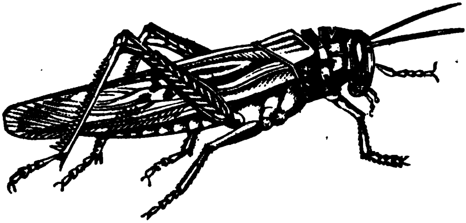

Fig. 35.—GRASSHOPPER.

LESSON III.

ORDER OF HEMIP'TERA.—*Organization —Division —Bed-bug —Locust—Plant-lice—Cochineal Insect.*
ORDER OF NEUROP'TERA.—*Dragon-flies—Ephe'mera—White Ants.*
ORDER OF LEPIDOP'TERA.—*Division—Butterflies—Sphinx—Bombyx—Silk-worm—Tineæ.*

ORDER OF HEMIP'TERA.

1. Insects of the order of Hemip'tera (from the Greek, '*emisus*, half, and *pteron*, wing) may be distinguished at first sight from the two preceding orders, by the conformation of the mouth, which, instead of being adapted to masticate food, is in the form of a long sucker resembling a tube. They have four wings; the two first are in general half coriaceous and half membranous, from which circumstance the order derives its name (*figs.* 36 and 37).

2. In general the tegumentary covering of the Hemip'teræ is crustaceous; sometimes, besides the compound eyes which exist in all insects, we find simple eyes or ocelli; the elytra are sometimes one-half crustaceous or coriaceous, and half membranous, and at other times entirely membranous; sometimes they, as well as the wings, are wanting. The metamorphosis of the Hemip'teræ is generally incomplete, and consists only in the development of wings and the growth of other parts of the body. The organization of the mouth makes these insects necessarily suckers; it is composed of a sheath formed by the labium or lower lip, and contains two pairs of filaments.

3. This order is divided into two sections; namely,

1st. The HETEROP'TERÆ (from the Greek, '*eteros*, various, and *pteron*, wing), in which the elytra are hard and thick at the base, and membranous at the extremity (*fig.* 36).

2d. The HOMOP'TERÆ (from the Greek, *omos*, the same, and *pteron*, wing), in which the elytra or first pair of wings are of the same consistence throughout (*figs.* 37 and 39).

4. The Heterop'teræ have a large and frequently triangular

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1. How is the order of Hemip'tera distinguished?
2. What is the character of the teguments of Hemip'terans? What is the nature of their metamorphosis?
3. How is the order of Hemip'tera divided?
4. How is the section of Heterop'teræ characterized?

corselet, and a thick beak inserted beneath the front. They are designated under the common name of bugs, and are divided into Geo'corisæ (from the Greek, *ge*, land, and *koris*, bug) or land-bugs, and Hydro'corisæ (from the Greek, *'udor*, water, and *koris*, bug) or water-bugs.

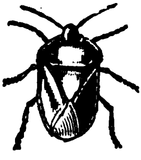

Fig. 36.
PENTATOMA.

The Pentato'ma (*fig.* 36) is the type of the *family of Geo'corisæ.*

5. The *bugs, properly so called* (*Cimex*), also belong to this family; they have a soft flattened body, and are unprovided with wings. The too well-known insect, vulgarly called the *bed-bug* (*Cimex lectularius*), sucks the blood of man while he sleeps, and when in danger, or when crushed, exhales a fetid odour; it is the scourge of old dirty houses; during winter, it is torpid. It is pretended that this insect did not exist in England previous to the fire of London in 1666, and that it was transported thither in timber from America. They were known long before that time on the continent of Europe. Great cleanliness and extreme vigilance are the best means of keeping clear of these noxious insects.

6. The Homop'teræ, in which the elytra, in place of being horizontal as in the preceding, are inclined and similar to wings, live exclusively on the juices of plants, and are generally remarkable for the length of the beak which arises from the inferior and posterior part of the head.

Fig. 37.—LOCUST.

7. The *locust—Cicada—* (*fig.* 37)—belongs to this family. The males make a monotonous noisy kind of music, which is produced by an organ situated at each side of the base of the abdomen. They live on trees and suck their sap; one species is in the habit of stinging a species of the ash, causing an exudation of a honey-like juice, which, growing thick by evaporation in the air, constitutes manna. The elytra are almost always transparent and veined. The female deposits her eggs in the pith of dead twigs. The young larvæ leave their asylum to penetrate the earth, where they grow and experience their metamorphosis.

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5. What are the characters of the genus Cimex?
6. What are the characters of the section Homop'tera?
7. What are the habits of locusts? How is manna produced? Where do locusts deposit their eggs?

8. The plant-lice—*Aphis*—(*fig.* 38)—are very small homop'terans; they have a soft body, and are found in myriads in our gardens; they live in companies on trees, the rose, ivy, oak, apple, &c., and suck the sap by aid of their trunk.

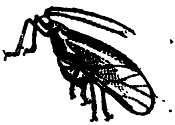

Fig. 38.—APHIS.

9. The *cochineal insect* (*Coccus*) is very similar to plant-lice. The males (*fig.* 39) have wings, but the females (*fig.* 40) have none. Most of these insects at a particular season of the year attach themselves to the plants on which they feed; the males to experience their metamorphosis, and the females to pass their lives. The substance called *cochineal*, so much used in dyeing, is the dried bodies of certain insects of this genus. The insects which furnish the most beautiful scarlet live on a kind of cactus called nopal or opuntia, which is cultivated in Mexico and other parts of South America, solely on account of these animals. They are native of America, and have been found in South Carolina.

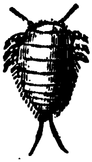

Fig. 40.
COCHINEAL.

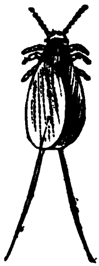

Fig. 39.
COCHINEAL.

ORDER OF NEUROP'TERA.

10. The Neurop'teræ (from the Greek, *neuron*, nerve, and *pteron*, wing) are distinguished from other insects by their wings, all four of which are membranous, transparent and reticulated (that is, formed in very fine net-work), and by the organization of the mouth, which is armed with mandibles and jaws adapted to mastication (*fig.* 41).

11. The general form of these insects is elongated, and their teguments almost always soft. Most of them are carnivorous. The larvæ always have six legs terminated by hooks; their metamorphosis is various, but generally incomplete.

The most interesting insects of this order are the *Dragon-flies*, *Ephe'meræ*, and *Ter'mites*.

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8. What are plant-lice?
9. What is cochineal dye? How does the male differ from the female cochineal insect?
10. How is the order of Neurop'tera distinguished?
11. What are the habits of the Neurop'teræ?

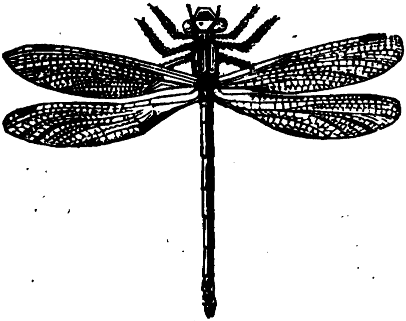

Fig. 41.—DRAGON-FLY.

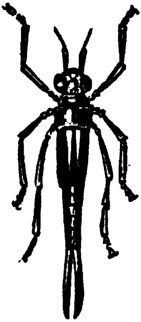

Fig. 42.
LARVA OF DRAGON-FLY.

12. The *Dragon-flies*—(*fig.* 41)—*Libel'lula*—are remarkable for their elongated form, their varied colours, their large, beautiful, gauze-like wings, and their rapidity of flight. Their larvæ and nymphæ (*fig.* 42) live in the water until the period of their last transformation. In the two first states they resemble the perfect insect, except that they have no wings, and the head, yet unprovided with simple eyes, has a mark in front covering the mandibles, which is furnished with movable pincers, by means of which the animal seizes its prey. At the posterior extremity of the abdomen (*fig.* 42) we remark lamellar appendages which the larva constantly expands, while at the same moment it dilates the rectum to cause water to enter it; then it forcibly expels the water mingled with bubbles of air, both for the purpose of locomotion and breathing.

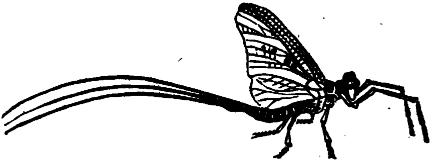

Fig. 43.—EPHEMERA.

13. The *Ephe'meræ* (*fig.* 43) have a very soft body terminated by two or three long setæ or filaments. As their name indicates, these insects live but a very short time; they usually appear in

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12. What are the characters of Dragon-flies? How do their larvæ differ from the perfect insect?

13. What are the characters of Ephemeræ? What are their habits? How does the larva differ from the perfect insect?

numerous swarms along the banks of rivers, towards sunset, on bright days in the warm season. They assemble in the air and then alight on neighbouring plants; soon afterwards the female lays her eggs in the water and dies. These insects sometimes fall upon the ground in such great numbers that they are gathered up in cart-loads for manuring the earth. But notwithstanding they live in the perfect state only a few hours, they undergo transformation and clothe themselves in a new skin. In the state of larvæ or nymphæ, on the contrary, they live two or three years and remain in the water. The larva resembles the perfect insect; but the mouth has two projections in form of horns, and the abdomen has on each side a row of plates or leaflets, serving for respiration and swimming. The pupa or nympha does not differ from the larva except in the presence of sheaths enclosing the wings. At the moment these organs are to be developed, the insect leaves the water; and it is a remarkable exception to the general rule, that after having undergone this metamorphosis, it again changes its skin before it becomes an adult.

14. The *Ter'mites* are only found in countries situated near the tropics, and are known under the common name of *white ants.* These insects live in very numerous societies, composed of males, females, larvæ, nymphs, and neuters or adults; the last are however incomplete, wanting wings; they are called ***soldiers.*** They keep under ground or in the interior of trees, joists, &c., and in them dig very extensive and numerous galleries, all of which communicate with a central place where they dwell; these habitations are always covered, and when circumstances compel the larvæ to leave it, they form beyond, from the materials they gnaw, tubes or covered ways which hide them from view. The soldiers, which have a larger head, and mandibles more apparent than the others, are charged with the defence of the common dwelling, and it is for this reason they have obtained the name of soldiers; they keep near the external surface of the habitation, and as soon as a breach is made, they rush out to fight their enemies. The *larvæ,* which are called *working ter'mites,* are much more numerous than the soldiers; they perform all the labour necessary for the construction and repair of their dwellings; they cause terrible destruction by mining, as it were, through trees and the frames of houses. Having attained the perfect state, the ter'mites quit their nest towards evening and rise in the air; but on the rising of the sun their wings dry and they fall, the most of them becoming a prey to lizards, birds, &c.; but we are assured that, at this period, the larvæ make prisoners of the females and keep them in a particular cell in the centre of the

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14. What are Ter'mites? What are their habits?

habitation, for the purpose of augmenting the colony by the addition of their offspring. At first a certain number of larvæ stand guard at the entrance of this cell; but the abdomen of the captive female acquires so great a volume that she cannot pass the entrance of the cell, which the larvæ are even obliged to enlarge. The same larvæ are careful to lodge in a particular cell the eggs she lays and provide food for them. There is a species of termites, called *lucifugus*, which is multiplied to such a degree in the workshops and store-houses, in the dock-yard at Rochefort, as to cause serious damage.

"When they find their way," says Kirby, "into houses or warehouses, nothing less hard than metal or glass escapes their ravages. Their favourite food, however, is wood, and so infinite is the multitude of assailants, and such the excellence of their tools, that all the timber-work of a spacious apartment is often destroyed by them in a night. Outwardly every thing appears as if untouched; for these wary depredators—and this is what constitutes the greatest singularity in their history—carry on all their operations by sap or mine, destroying first the inside of solid substances, and scarcely ever attacking the outside, until first they have concealed it and their operations with a coat of clay."

It is related that "an engineer having returned from surveying the country, left his trunk on a table: the next morning he found not only all his clothes destroyed by the white ants or cutters, but his papers also, and the latter in such a manner, that there was not a bit left of an inch square. The black-lead of his pencils was consumed; the clothes were not entirely cut to pieces and carried away, but appeared as if moth-eaten, there being scarcely a piece as large as a shilling free from small holes. 'One night,' says Kemper, in his history of Japan, 'in a few hours, they pierced one foot of the table, and having in that manner ascended, carried their arch across it, and then down, through the middle of the other foot, into the floor, as good luck would have it, without doing any damage to the papers left there.' "—*History of Insects in the Family Library.*

ORDER OF LEPIDOP'TERA.

15. The Lepidop'teræ (from the Greek, *lepis*, a scale, and *pteron*, wing) or butterflies are recognised by the scaly dust, similar to coloured flour, which covers their four membranous wings, and by their mouth, which is in form of a tube spirally rolled up (*fig.* 11).

16. These insects experience complete metamorphosis; their larvæ, which are known under the name of caterpillars (*figs.* 17 and 18), have six scaly legs corresponding to those of the perfect insect, and four or six membranous feet which subsequently disappear; in general the body is almost cylindrical, soft, and differently coloured. Most of them feed on leaves or other parts

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15. How is the order of Lepidop'tera recognised?

16. What are the characters of the larvæ of Lepidop'teræ? What is a chrysalid?

of vegetables; but there are some that eat woollen stuffs, peltries, &c. Generally these animals change the skin four times; and when they are about being transformed into the nympha or pupa state, they enclose themselves in a shell or cocoon, constructed of a silky material, secreted in particular organs, and forced out through a kind of lip. In the nympha state, the Lepidop'teræ resemble a mummy, and are called *chrysalids* (*fig.* 44); they are swathed, and when they have undergone the changes they are destined to experience, they escape from their case through a slit they make on the back of the corselet. In the perfect state, these animals feed exclusively on the honey of flowers.

Fig. 44.
CHRYSALID.

17. The order of Lepidop'tera is divided into three great families; namely, ***Diurnal Lepidop'teræ***, ***Crepuscular Lepidop'teræ***, and ***Nocturnal Lepidop'teræ***.

18. The DIURNAL LEPIDOP'TERÆ are recognised by their wings, which are vertical when in repose (*fig.* 45), while in the other two families they are horizontal or inclined. Their antennæ are generally terminated by a small rounded club-like mass; sometimes, however, they are tapering at the extremity, and curved

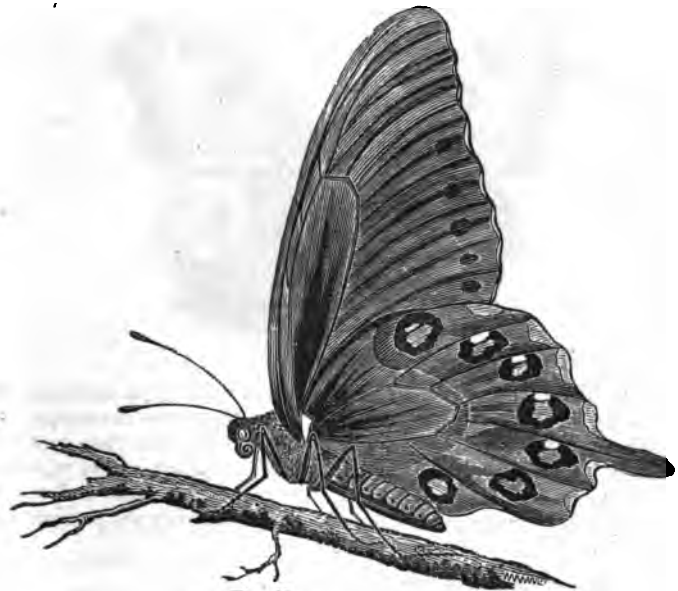

Fig. 45.—PAPILIO PHILENOR.

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17. How is the order of Lepidop'tera divided?
18. How are the Diurnal Lepidop'teræ distinguished? What are their habits?

so as to form a hook. These butterflies, as their name indicates, fly and seek their food only during the day; their colours are generally bright and agreeably variegated. Their caterpillars always have six legs, and the chrysalid is seldom enclosed in a cocoon, but is suspended by the posterior extremity of the body. In this family are the *butterflies, properly so called, Vanessa*, &c.

19. As an example of the first we will mention the ***Papilio philenor*** (*fig.* 45), one of the most beautiful of our butterflies. It is characterized by a black head, thorax and legs; breast dotted with yellow; the superior wings are dark green, with white spots on the margin; the inferior wings highly polished green, with spots of pearl-white and fulvous, the latter surrounded by a black ring. The caterpillars of this genus are destitute of spines or hairs; but when disturbed they suddenly project from the superior part of the neck a soft bifid or forked appendage, which diffuses a strong odour. This singular organ, although somewhat formidable in appearance, is yet perfectly harmless; it may, however, serve the purpose of repelling the enemies of the larva, rather, perhaps, by the odour it emits, than by its menacing aspect.

20. The genus ***Vanessa*** comprises several species. Their caterpillars are armed with numerous spines (*fig.* 46).

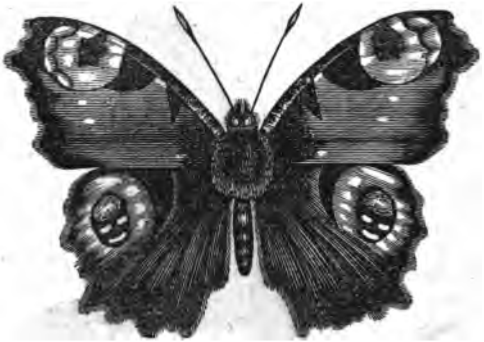

Fig. 46.—VANESSA.

21. The CREPUSCULAR LEPIDOP'TERÆ only fly in morning or evening twilight. When in repose, their wings are horizontal or inclined, a position which is attributable to the fact that in this family the inferior wings have a stiff bristle which serves to support the superior. The antennæ are elongated clubs, and commonly prismatic or spindle-shaped; sometimes they are pectinate; their caterpillars always have six legs.

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19. How is the Papilio philenor characterized?

20. How are the caterpillars of the genus Vanessa characterized?

21. Why are the wings of Crepuscular Lepidop'teræ, when in repose, horizontal or inclined?

22. The type of this family is the genus *Sphinx*, so called, because sometimes the attitude of its caterpillar resembles that of the sphinx of fable; they fly with great rapidity and hover above flowers.

23. The largest species in France is the *Sphinx atropos*, so named, in consequence of a spot on the back resembling somewhat a death's head. Its caterpillar is yellow with blue stripes on the side; it lives on the potatoe-vine, jasmin, &c., and changes to a nymph, about the end of August; the perfect insect appears in September.

24. The Nocturnal Lepidop'teræ always have horizontal or inclined wings when in repose; the superior wings are almost always retained against the inferior (*fig.* 47); in this respect they resemble the crepuscular lepidop'teræ, but are distinguished from them by their antennæ, which diminish in size from the base to the point, or in other words, they are seta'ceous. These lepidop'teræ, which are sometimes called phalænæ, ordinarily fly only at night or in the evening after sunset; in some species the females are without wings, or have them very small. Their chrysalids are almost always round and lodged in a cocoon.

This family is very numerous, and is divided into several tribes; the most interesting is that of the *Bom'byces*, which have inclined wings, forming a triangle with the body.

Fig. 47.—BOMBYX.

25. The mulberry bombyx —*Bombyx mori*—(*fig.* 47)— of all insects is the most interesting, because its caterpillar, known under the name of *silk-worm*, furnishes us with silk. In the perfect state, this butterfly is whitish, with two or three darkish transverse stripes, and a cross-like spot on the superior wings. Its caterpillar (*fig.* 48) has a smooth body, and at birth scarcely exceeds a line in length; but attains in time to even more than three inches long. In this form the silk-worm lives about thirty-four days, and during this time changes

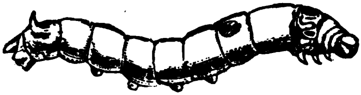

Fig. 48.—SILK-WORM.

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22. What is a Sphinx?

23. How is the caterpillar of the Sphinx atropos characterized?

24. How are the Nocturnal Lepidop'teræ distinguished? What are their habits?

25. What are silk-worms? What are the characters of the bombyx mori? What are the habits of its larva? What is the colour of its cocoon?

its skin four times; it feeds on the leaves of the mulberry; at the time of moulting it becomes torpid and does not eat; but after changing its skin, its appetite is doubled. When it is ready to change into a chrysalis, it becomes flaccid and soft, and seeks a proper place to construct its cocoon, in which it encloses itself; the first day is occupied in attaching, in an irregular manner, threads of silk to neighbouring bodies to support it; the second day it begins to multiply these threads so as to envelope itself; and on the third day it is entirely concealed in its cocoon. This nest is formed of a single filament of silk wrapped around the animal, and its turns glued together by a kind of gum. It is estimated that the length of this filament in an ordinary cocoon is nine hundred feet. The form of the cocoon is oval, and its colour either yellow or white.

26. The bombyx remains in the chrysalis state, in the interior of its cocoon, about twenty days; and when it has finished its metamorphosis, it disgorges upon a point of its parietes a particular liquid, which softens it and enables the animal to make a round hole through which it escapes.

27. This precious caterpillar appears to be originally from the northern part of China, and, about the time of Justinian, was imported into Europe by the Greek missionaries; but it was not until the period of the Crusades that its culture passed from Greece into Italy and Sicily. Some gentlemen who accompanied Charles VIII. into Italy during the war of 1494 introduced these insects into the south of France, as well as the mulberry, a tree without which silk-worms cannot be raised; but for a long time it attracted very little attention. In the present day, however, this branch of agricultural industry forms one of the chief sources of wealth of southern France; and is yearly becoming of more and more importance in the United States.

28. To obtain the silk produced by these animals, it is necessary to kill them before they pierce the cocoon, and then wind or reel off the thread or filament of which it is composed; to unglue it, the cocoons are soaked in warm water; then the filaments of three or four are united into one thread. That part of the cocoon which cannot be reeled in this manner is carded, and constitutes floss-silk.

29. The mulberry bombyx is not the only species of this genus which yields silk that can be usefully employed; the inhabitants of Madagascar make use of a species, the caterpillars of which live

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26. How does the bombyx escape from its cocoon?
27. What is the history of the silk-worm?
28. How is the silk obtained? What is *floss-silk?*
29. Is there any other species of Bombyx which produces silk?

in numerous bands, and form a common nest, sometimes three feet high, containing about five hundred cocoons.

30. A species of bombyx called *processionne'a*, has analogous habits, but instead of being useful, is very destructive; the body of the caterpillars is ash-coloured, with a black back spotted yellow; they live in society on the oak, and while young, spin a web or tent in common, under which they are all sheltered; they frequently change their domicil, and generally they leave their retreat in the evening, following a regular order; one marches ahead, then follows two, then three, and so on, increasing each rank by one; this description of procession has given them their specific name.

31. The *Tineæ* or Moths, whose caterpillars frequently feed on cloth and peltry, are also nocturnal lepidop'teræ. The *clothes-moth*, *fur-moth*, *grease-moth*, *grain-moth*, and various other destructive moths are mostly very small insects; the largest of them, when arrived at maturity, expanding their wings about eight-tenths of an inch. The *Tinea sarcitella* or pack-moth, which is very destructive to woollen, is silver-gray, and has a white dot on each side of the thorax. Its caterpillar lives on cloth and other woollens, weaving with their detached particles mixed with silk a portable tube; it lengthens it one end in proportion as it grows, and slits it to increase its diameter by adding another piece. From this circumstance it obtains the specific name, *sarcitella*, which is formed from the Latin, *sarcio*, I patch.

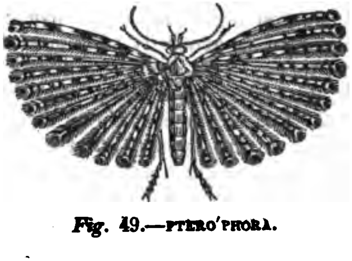

Fig. 49.—PTERO'PHORA.

32. Belonging to the family of nocturnal lepidop'tera is the tribe of FISSIPENNÆ: this tribe is distinguished from all other lepidop'teræ by the singular structure of the wings, which, in a state of repose, are straight and elongated. The four wings, or two of them at least, are slit through their whole length into branches, which are barbed on the sides, bearing some resemblance to an outspread feather fan. All these anomalous insects are included in a single genus, named PTERO'PHORA (*fig.* 49).

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30. What are the habits of the Bombyx processionne'a ?
31. What are Tineæ ?
32. What are Fissipennæ ?

LESSON IV.

Order of Hymenop'tera.—*Organization—Ichneumon Fly—Galls—Wasps—Hornets—Ants—Bees.*
Order of Rhipip'tera.
Order of Dip'tera.—*Mosquitoes—Flies—Œstrus.*
Class of Myria'poda.—*Scolopendra.*

ORDER OF HYMENOP'TERA.

1. Insects of the order of Hymenop'tera (from the Greek, '*umen*, a membrane, and *pteron*, wing) have, like the Neurop'teræ, four membranous, naked wings, that is, they are without the coloured dust-like scales which cover those of the Lepidop'teræ; the mouth is composed of mandibles, which in general are very different in form from those of triturating insects (*tritores*); but the maxillæ and ligula are elongated in such a manner as to constitute a tube adapted exclusively to suction; their wings are veined, instead of being reticulated as in the Neurop'teræ, and the superior are always larger than the inferior. The tegumentary envelope of these insects is not crustaceous; besides the compound eyes, they always have three small simple eyes. When in repose the wings are placed horizontally over the body. The tarsi are composed of five complete articulations; and the abdomen is generally suspended from the posterior extremity of the thorax, by a straight peduncle; and in the females this part of the body is terminated by an ovipositor or sting.

2. The metamorphosis of these insects is complete; most of the larvæ are apodous, that is, without feet; but some are provided with six or a greater number of legs.

3. In the perfect state, almost all the Hymenop'teræ live on flowers, and many of them form numerous societies, the labours of which are performed in common. In the larva state, some feed on dead insects, others on vegetable substances, and when these animals are unprovided with legs, and consequently incapable of seeking food, the mother places them, sometimes in the bodies of animals at whose cost they are destined to live, sometimes in nests, and then she or others of the society regularly bring them food.

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1. What are the characters of Hymenop'terans?
2. What description of metamorphosis do they undergo?
3. What are the habits of the Hymenop'teræ?

4. Some, designated by the common name of TEREBRAN'TIA (from the Latin, *terebro*, I bore), have, in the female, the abdomen terminated by a simple borer, most generally in form of a saw, which they use to deposit their eggs in suitable places. Of this number are the *Ichneumon flies*, insects which render essential service to agriculture by destroying a great many caterpillars; the *Cynips*, which have a small head, and a large, raised up corselet, which gives them the appearance of being hump-backed. The females make excavations in trees for depositing their eggs, and the juices effused at the wounded spot often produce excrescences named *galls*. The gall-nut, of which considerable use is made in dyeing black, and in the manufacture of ink, is developed in this manner on the leaves of a species of oak which grows in Asia Minor.

5. Other hymenop'teræ have the abdomen attached to the thorax by a straight peduncle, and in place of the ovipositor there exists in most of the females and most *neuters*, a retractile sting. They form a group of ACU'LEATES (from the Latin, *aculeus*, a prickle or sting). The most interesting insects of this division are the *wasps*, *ants*, and *bees*.

6. *Wasps*—*Vespa*—are so generally known that it is not necessary to describe their form; but their habits are worthy of attention. These insects, like some other hymenop'teræ, live in society. Only the females found new colonies; in the spring they lay their eggs, from which are derived individuals called *workers*, who assist their common mother to enlarge the nest and raise the young born afterwards. To construct their nest or *vespiary*, these insects by aid of their mandibles detach pieces of bark or old wood, which they reduce to a sort of paper-like paste; of this they form the combs or nests, which are generally horizontal, suspended by pedicles, and present at the lower edge series of hexagonal cells, serving for the lodgment of the larvæ and pupæ. These cells are ranged parallel to each other, at regular distances, and are joined together at intervals by little columns which support them (*fig.* 50); the whole is built, sometimes in the open air, sometimes in the hollow of a tree, and some are naked or enclosed in a common envelope, according to the species (*fig.* 50). The cells, which vary in number, are sometimes covered and communicate externally by a common aperture. It is only in the beginning of autumn that male wasps are found in the vespiary; the young females make their appearance about the same time. About the month of November the young wasps that have not yet completed their last metamorphosis, are put to

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4. What are gall-nuts?
5. What insects are comprised in the group of Aculeates?
6. What are the habits of wasps?

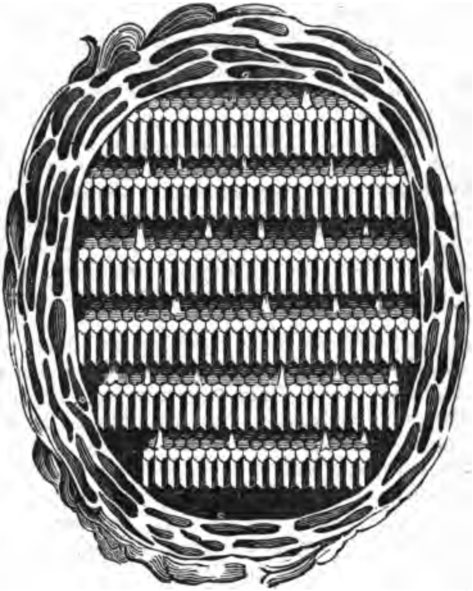

Fig. 50.—VESPIARY OR WASP'S NEST.

death and thrown out of the cells by the neuters, who, as well as the males, perish when cold weather arrives; so that the preservation of the species is confided exclusively to the few females who resist the inclemency of winter and survive till spring.

"Cruel and ferocious as these insects may appear, still their affection for their habitation and young is very striking. Whatever injury may be done to the nest, if it should be even broken to pieces, they will linger about the cherished spot, or quit it only to follow the combs wherever they may be transferred. 'Those,' says Reaumur, 'which were absent when I removed the nest, finding, on their return, neither companions nor home, knew not where to go, and for days together hovered around the hole before they determined to abandon the spot.' The material from which the nest is constructed is vegetable fibre. The wasp will not use saw-dust; but, knowing that a filamentous material, like linen rags, is necessary for the fabrication of its paper, it amasses pieces of some substance possessing this quality. As the first step in the process of paper-making is to soak the vegetable fibre in water, so the wasp takes especial care to select the filaments which it intends to use from wet wood which has rotted in the rain. These are worked up with a glutinous secretion, and thus the material is prepared. When the wasp can get its paper ready made, it makes no scruple to appropriate it. Reaumur, being once disturbed by a noise in his study, found that it arose from the gnawing of a piece of paper which these insects had attacked. A few only of the community are architects; the rest having other appropriate employments. The females (for there are as many as three hundred), unlike the queen bee, do not pass their lives in receiving the homage of their subjects, but perform every species of labour. The neuters, however, as among bees, are the true workers. They build the nest and forage for food for the males, females, and the young. The worms are not locked up in a cell surrounded by food, but require to be fed like the young of birds. 'I saw,' says Reaumur, 'a female wasp, which had entered the vespiary with the belly of an insect; this she contrived by degrees to swallow, after which she ran to various cells, and disgorging that which she had eaten, distributed it among the brood of worms.' Hence it appears that it not only procured the food, but prepared it by a partial digestion. The wasp is particularly fond of the belly of the bee; it is a choice bit which it eagerly seeks. It will watch for hours at the door of a bee-hive, pounce upon some unfortunate bee which is about to enter, and tumbling it to the ground, in a trice separate, with its two serrated teeth, the tender abdomen, containing the soft intestines and the honey-bag, from the dry and hard chest of the insect; having secured its prey, it hurries away to its habitation. The large blue bottle-fly is another delicate morsel greatly coveted by the wasp."—*Family Library.*

The hornet is the largest of the wasp tribe. It is a terrible enemy of the hive bee; its sting is very dangerous even to man.

7. The *ants*—*Formica*—also present three kinds of individuals, males, females, and workers; they live in societies composed chiefly of workers who are unprovided with wings; so soon as the males and females have acquired wings they leave the habitation; the males soon after die, and the females that are to become mothers quickly lose their wings; some go off to found new colonies, others are held prisoners by the neuters in the old habitation, and there lay their eggs. The manner of constructing these dwellings, and in fact every thing relating to the habits of ants, is extremely curious. In general the larvæ dig in the earth a multitude of galleries, chambers arranged in stories, and, carrying out the dirt, often raise up above the nest a little hill, in the interior of which these indefatigable workmen form new stories similar to those below; sometimes they construct from this dirt, galleries which they carry up along the stems of shrubs on which these insects go in pursuit of food, and which shelter them in their daily journeys. Other ants construct their nests in trees that have been already attacked by other insects and softened by decay. The larvæ also receive assiduous attention from the workers; each one is supplied by the latter with the juices proper for it, and, when the weather is fine, we observe these active nurses carry the young out of the nest to expose them to the rays of the sun, defend them from their enemies, transport them back again to the nest on the approach of evening, and keep them clean.

8. *Bees* (*fig.* 51)—*Apis*—and some other Hymenop'teræ pre

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7. What are the habits of ants?
8. What are the characters of bees?

Fig. 51.—HONEY-BEE.

sent a peculiar conformation of the hind legs, which is characteristic of them; the first articulation of the tarsus of these legs is very large, compressed in form of a palette and armed with a silky brush; on the external side of the leg or tibia there is also a depression bordered by hairs, named a basket; the insect makes use of these organs for collecting the pollen of flowers. *Honey-bees* are distinguished from other social bees by the absence of spines on the extremity of the hind legs.

9. Of all insects that live in society these are the most interesting to us; for by their admirable industry we are furnished with honey and wax. These little animals establish their dwellings in some cavity, such as holes in trees, or in a kind of cage which farmers prepare for them, called a *hive*. The inhabitants of each hive or colony formed by bees are for the most part *workers* or *drones;* during a part of the year we also find a certain number of males; but only one female resides among them, and she is the sovereign, the Queen. The *working bees* perform all the labour; they collect pollen and honey, build the cells of wax in which are deposited the eggs and provisions of the community, take care of the young and defend the hive from enemies. The males, commonly called *drones*, are only useful for a short time, and before autumn the workers destroy them without pity. The cells just mentioned are in form of a little hexagonal cup, and constitute by their union in series, regularly placed in rows one above the other, back to back, masses whose regularity and finish always excite our admiration (*fig.* 52): they are called *honey-comb*, and there are two kinds of cells; the common (*a*) and the royal cells (*b*).

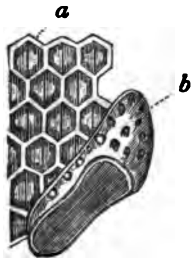

Fig. 52.
HONEY-COMB.

10. When the period for laying arrives, the Queen, now an object of respect and of the most assiduous care on the part of the workers, runs through the comb, examines the cells, and deposits her eggs in them, first in those that are smallest (*a*) and destined for the larvæ of workers; then in those of still larger dimensions, which are designed to lodge the males; and, lastly, in those named royal cells (*b*), in consequence of their size and their

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9. What are the habits of bees?

10. Are the cells of a bee-hive all of the same size? What are royal cells? What is bee-bread?

special destination for the larvæ of females. When the number of these chambers is too small, and the female deposits several eggs in the same cell, the workers soon perceive it, and destroy them all except one. Three days after laying, those workers who have not contributed to the construction of the comb, but have collected pollen and honey to be deposited in magazines constructed for the purpose, begin to discharge the duty of nurses to the newly born larvæ, bringing them several times daily a kind of mixture varied according to the age and sex of those for whom it is intended. This mixture is known under the name of bee-bread.

11. These larvæ are completely *apodous*, without feet, and resemble small worms; six or seven days after birth, they prepare for undergoing their metamorphosis, and the nurses then enclose them in their cells, closing the latter with a cover of wax; they remain in the nympha or pupa state about eleven days, and then disengage themselves and appear in the form of bees. When the number of bees contained in the hive becomes too great to be comfortably accommodated, a part of them, led by a female, emigrate and found a new colony, termed a *swarm*.

Although the habits of bees are very interesting, our limits require us to refer the reader for their history to some of the several works specially treating of them. A very entertaining and correct account of them is contained in the "Natural History of Insects," published in Harper's Family Library.

ORDER OF RHIPIP'TERA.

12. The order of Rhipip'tera (from the Greek, *ripis*, a fan, and *pteron*, wing) is composed of a small number of insects, very remarkable on account of their habits and anomalous form. They may be recognised by their two large membranous wings, longitudinally folded like a fan. In the larva state they form a little oval worm, without legs, and live among the scales of some species of Hymenop'teræ, as wasps, for example; in the same situation they change into the nympha state.

ORDER OF DIP'TERA.

13. The order of Dip'tera (from the Greek, *dis*, two, and *pteron*, wing) is composed of insects that have only two wings, which are membranous and extended (*fig.* 53).

14. The general envelope of these insects is very thin, and

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11. What are the characters of the larvæ of bees?
12. How is the order of Rhipip'tera recognised?
13. How is the order of Dip'tera recognised?
14. What are the characters of the Dip'tera?

possesses very little consistence; the mouth is in form of a trunk, and is only adapted to sucking; their legs are generally long and slender; and the abdomen is more or less pedunculated.

15. The dip'teræ experience complete metamorphosis. The larvæ are apodous, and their head is soft and variable; their mouth is commonly furnished with two hooks. In most of them it is the skin of the larva, which, by becoming hard, serves as a cocoon for the nympha, and then puts on the appearance of a seed or egg.

This division is very numerous both in genera and species; besides a great many other insects, we place in it *mosquitoes*, *flies*, &c.

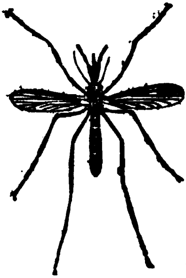

Fig. 53.—MOSQUITO.

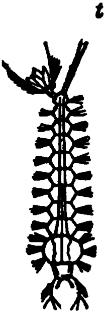

Fig. 54.—LARVA.

16. The *mosquitoes* — *Culex* — (*fig.* 53) — have a long hairy body, antennæ in form of plumes, and very long legs. The inconvenience and annoyance of these insects are well known, particularly in damp, marshy situations, where they are found in the greatest abundance. Voraciously fond of blood, they pursue us everywhere, enter our dwellings, especially in the evening, and announcing their approach by a sharp humming sound, pierce the skin with the bristle-like lancets in their trunk and distil a venomous liquid into the little wound thus made. In the state of larva and nympha, mosquitoes live in water. The larva has on the segment of the abdomen next to the last a long tube (*fig.* 54, *t*), by means of which it draws from the atmosphere the air it requires: the nympha breathes in the same manner, but by means of two tubes placed on the thorax; it floats on the surface of the water, and, after having finished its metamorphosis, the perfect insect makes use of its nympha slough or cast skin, as a boat, until its legs and wings have acquired sufficient solidity to enable it to walk on the surface of the water, or betake itself to flight; for, if its body were submerged, as often happens when the wind overturns their frail barks, they would invariably drown. All these metamorphoses occur in the course of three or four weeks: thus, generations are renewed three or four times in the same year.

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15. How are the larvæ of dip'terous insects characterized?

16. What are the characters of mosquitoes? What are the characters and habits of their larvæ?

17. The number of species of flies (*Musca*) is very great. Their larvæ feed on meat, carrion, &c.: they are in form of soft, whitish worms, and are frequently termed *Maggots*.

18. The *gad-flies* (*Œstrus*) resemble large flies; their flight is accompanied by a humming noise; they are very tormenting to horses, oxen, &c.; some of them pierce the skin of these animals to deposit their eggs; others simply lay their eggs in the vicinity of one of the natural apertures of the body, and the larvæ in this manner at birth enter the stomach through the nostrils or nasal sinus. The larvæ of the Œstri are usually conical and entirely destitute of feet; their presence in horses constitutes the disease termed *bots*.

CLASS OF MYRIA'PODA.

19. The *Myria'pods* (from the Greek, *murias*, ten thousand, and *pous*, foot) breathe air by means of tracheæ, like insects, but differ very considerably from these animals, as well as from arach'nidans, in their general conformation. They never possess wings, and the body, which is very much elongated and divided into a great many segments or rings, bears on each ring, at least one pair of legs; the number of these organs is twenty-four, or even more, and there is no line of demarcation between the thorax and abdomen. They bear some resemblance to serpents, or rather to what worms would be if provided with legs, but their internal organization is similar to that of insects.

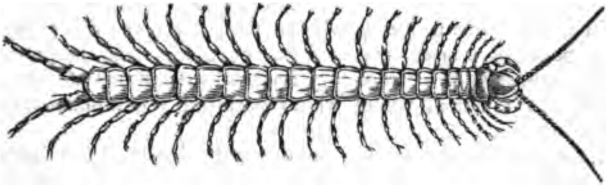

Fig. 55.—SCOLOPEN'DRA.

20. The head is furnished with two antennæ and two eyes ordinarily formed by the union of ocelli. The mouth is formed for mastication. The number of rings of the body varies. They experience while young an imperfect metamorphosis, but these changes are not similar to those we observe in insects properly

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17. What are maggots?
18. What are the characters of gad-flies?
19. What are the characters of the class Myria'poda?
20. To what description of metamorphosis are myria'pods subject?

so called, and consist merely in the formation of new rings and a corresponding increase in the number of legs.

The centipedes (*Scolopen'dra*) belong to this class. Most of them live on the ground under stones and delight in the dark (*fig.* 55).

LESSON V.

CLASS OF ARACH'NIDANS.—*Organization—Habits—Classification.*

ARACH'NIDA PULMONARIA.—*Aranei'dæ or Spinners—Mygale—Mason Spider—Ara'neæ sedenta'riæ—Ara'nea—Vagabun'dæ—Taren'tula—Scorpions.*

ARACH'NIDA TRACHEA'RIA.—*Mowers—Aca'rides—Mites—Itch Arach'nidan—Ticks.*

CLASS OF ARACH'NIDA.

1. The class of Arach'nidans (from the Greek, *arachen*, spider) is composed of animals, which, in their general organization, resemble spiders. Like crusta'ceans and insects, they are articulated animals with white blood (which is sufficient to distinguish them from anne'lidans); but they differ from crusta'ceans, in the fact that their aëreal respiratory organs communicate externally by means of openings called *stigmata* or spiracles, and they differ from insects in the number of their legs, which is eight, in the absence of a head distinct from the thorax, and, in general, by the existence of a circulatory apparatus composed of arteries, veins, and a dorsal vessel which performs the functions of a heart.

2. Most of these animals are of small size, and the body is divided into but two portions; namely, a first part, consisting of the head and thorax confounded in one piece (*fig.* 56); and a second, consisting of the abdomen.

3. The anterior portion or *cephalo-thorax* never bears antennæ as in other articulated animals; in this part we observe, in front and below, the mouth, which is furnished with mandibles; the jaw, almost always bearing palpi, and a lower lip; and posteriorly, the legs, which in the adult number four pairs. Arach'nidans never have wings, and their abdomen, which is gene-

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1. What are the characters of arachnidans?
2. How is the body divided?
3. What parts are borne by the cephalo-thorax?

rally globular, soft, and attached to the thorax by a sort of peduncle, never affords origin to legs.

4. The skin never possesses the hardness remarked in that of crusta'ceans; generally it is rather coria'ceous than horny; sometimes it has considerable consistence, and, in all cases, it forms a kind of external skeleton, to which the muscles designed to produce motion are attached.

5. Most arach'nidans are terrestrial animals, and accordingly, their legs are formed for walking or leaping. These organs are often very long, and are ordinarily terminated by two hooks. Of the senses of hearing and smell in these animals very little is known; on the upper and anterior part of the body, which represents the head, we find in almost all a certain number, commonly eight, shining points, which are the eyes. They are called *simple eyes*, to distinguish them from the compound or net-like eyes of insects; each one consists of a little, transparent cornea, which is convex and without any trace of division; beneath it we find a small vitreous body, a layer of colouring matter, and the termination of the optic nerve.

6. The nervous system of arach'nidans (*fig.* 56) is composed, 1st, of a pair of ganglia situated in the head in front of the œsophagus; 2d, two nervous cords which pass from this species of brain into the thorax, forming a collar around the œsophagus; 3d, a nervous mass situated in the thorax, beneath the digestive tube, composed of a certain number of ganglia which are commonly agglomerated; 4th, of one or more abdominal ganglia; and 5th, of nerves which pass from these different ganglia to all parts of the body.

7. Most arach'nidans are carnivorous. Some have their mouth armed with cutting or sharp jaws, and feed on insects which they seize alive; some fix themselves on other animals and live by sucking their blood; these parasites have a mouth formed like a sucker. We distinguish in the apparatus of manducation of the first: 1st, a pair of *mandibles*, which are generally armed with a movable claw; 2d, two jaws bearing articulated palpi; 3d, a small lip without palpi. The digestive canal extends to the extremity of the abdomen; close to the mouth we find salivary organs which open into the first joint of the mandibles, and appear to secrete a venomous liquid. And biliary tubes, which form a substitute for a liver, are attached to the digestive tube further back.

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4. What is the character of the skin of arach'nidans?
5. What is the character of the eyes of arach'nidans?
6. How is the nervous system constituted?
7. What is the character of the mouth in arach'nidans?

8. Most arach'nidans have a complete circulation. In these animals the heart is placed in the abdomen, and in several species of aranei'dæ (from the Latin, *ara'nea*, a spider) its pulsations can be distinguished through the teguments. It is a large longitudinal vessel, which gives rise to the arteries and receives the veins through which the blood returns from the respiratory organs to be again distributed to different parts of the body.

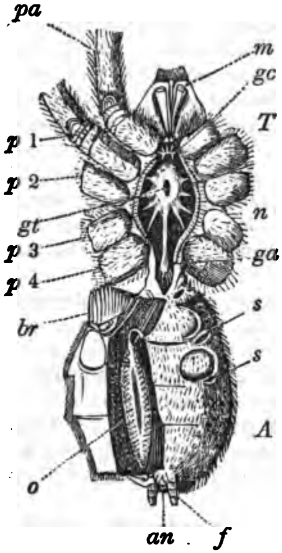

Fig. 56.—ARACH'NIDAN.

9. In this class of animals the organs of respiration differ exceedingly; in some they consist of pulmonary sacs, and in others, of tra'cheæ.

10. The *pulmonary* sacs (*br*, *fig.* 56) are small cavities, the parietes of which are formed by the union of a great number of extremely thin, white, minute triangular plates. The number of these respiratory pouches is generally two; but sometimes there are four or even eight. The apertures through which each one communicates externally, called *stigmata* or *spiracles* (*s*), are in form of minute transverse slits, situate at the inferior part of the abdomen.

11. The *tra'cheæ* are tubes that issue from or rather are continuous with apertures similar to those just mentioned, and are ramified through the substance of all the organs, so as to convey air to all parts of the body. This arrangement is represented in *fig.* 13 (page 25), which shows the arrangement in an insect.

Explanation of Fig. 56.—Anatomy of Arach'nidans.—A mygale seen from below. *T*, the ce'phalo-thorax;—*A*, the abdomen;—*m*, the mandibles;—*pa*, the palpi of the jaws;—*p* 1, *p* 2, *p* 3, *p* 4, bases of the legs;—*gc*, the cephalic ganglion or brain, behind which we see the nervous collar which surrounds the œsophagus;—*gt*, the nervous mass formed by the union of the thoracic ganglia;—*n*, nerves of the legs;—*ga*, abdominal ganglion;—*s*, stigmata or spiracles;—*br*, one of the pulmonary sacs opened to show the membranous laminæ which line it internally;—*o*, the ovary;—*an*, the anus;—*f*, the spinnerets.

8. What kind of circulation have arach'nidans?
9. Is the character of the respiration the same in all arach'nidans?
10. What are pulmonary sacs? What are stigmata?
11. What are tra'cheæ? (pronounced, *tra'-ke-ay*.)

12. Those arach'nidans that breathe by these tubes have no circulatory apparatus, while those that breathe by lungs are always provided with one.

13. After leaving the egg, these animals do not, like insects, undergo metamorphosis, although at this period they often have but six legs, the fourth pair not being developed until after the little creature has changed its skin; like the crusta'ceans, the arach'nidans frequently cast the skin or moult.

14. The class of arach'nidans is divided into two orders, which may be distinguished by the following characters:—

1st. The **Arach'nida Pulmona'ria** have eight simple eyes, and pulmonary sacs for respiration.

2d. The **Arach'nida Trachea'ria** have at most four simple eyes, and trach'eæ for respiration.

ORDER OF ARACH'NIDA PULMONA'RIA.

15. The division of pulmonary arachnidans includes all the common araneidæ. The circulatory apparatus is well developed, and they have from six to eight eyes, while the next order has but four or even only two. The number of stigmata is two, four, or eight.

16. This group is divided into two families: the *Aranei'dæ* or spinners, and the *Pedipalpi.*

17. The **Aranei'dæ** or spinners have but one or two pairs of pulmonary cavities, which may be distinguished by as many whitish or yellowish spots near the lower part of the abdomen; their palpi are in form of little feet without pincers at their extremity (*fig.* 56, *p*).

18. One of the most curious phenomena in the history of these animals is their mode of spinning silk, and with this delicate material making webs which are as remarkable for their extent as for the regularity with which they are woven. This silk is a matter secreted by a peculiar apparatus situated in the abdomen of the spider; it escapes externally by a certain number of *spinnerets* or small holes placed at the summits of several little nipples near the anus (*f*, *fig.* 56). The threads of silk at the moment of escaping are glutinous, and to be employed by the animal, require to be dried, but when the temperature is favour-

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12. Are trach'eæ in arachnidans accompanied by a circulatory apparatus?
13. Do arach'nidans experience metamorphosis?
14. How is the class of arach'nidans divided?
15. What are the characters of the pulmonary arach'nidans?
16. How are the pulmonary arach'nidans divided?
17. How are the aranei'dæ distinguished?
18. What is spiders' web? How is it formed? To what purposes is it applied?

able, an instant is sufficient for this purpose. The sedentary Aranei'dæ (those which do not go in pursuit of their prey) weave with these threads various structures which they use as snares to entrap the insects necessary for their nourishment; sometimes these webs are so strong as to arrest small birds, but generally they are very delicate. After constructing it, the animal places himself in its centre or at the bottom of its web, sometimes in a particular habitation situated near one of its angles; as soon as an insect is caught in the snare, he rapidly approaches his prey, and makes every effort to pierce it with a kind of venomous dart with which the mandibles are furnished, and distils into the wound a poison which acts very promptly; when the insect offers too strong resistance, or when it would be dangerous for the spider to contend with it, he retires for a moment to wait till its powers are exhausted, or until it is more entangled; or if there is nothing to fear, he hastens to bind it by throwing threads of silk around its body, which sometimes envelope it entirely, forming a covering so thick as to remove it from sight.

19. The female Aranei'dæ also employ their silk in constructing bags or cocoons to contain their eggs.

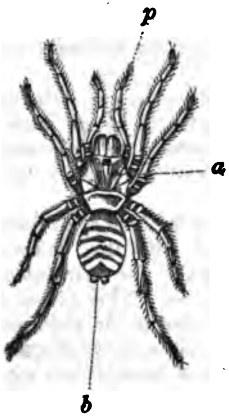

Fig. 57.—MYGALE.

20. Those white and silky flocculi, which are seen floating on the air, in foggy weather, in the spring and autumn, are composed of silk of this kind produced by various young Aranei'dæ; they are principally the strong threads which serve to attach the corners of the web, or those which compose the chain, and, having become heavier by the action of the moisture, sink, approach each other, and finally form little pellets.

21. Most Arach'nidans of this division are more or less venomous; the bite of some large species in hot countries is sometimes fatal to man; and in our climate, a spider of moderate size will kill a fly in a few minutes by inflicting a single wound.

22. The MYGALES (*fig.* 57), which

Explanation of Fig. 57.—The mygale or *mason spider*;—*a*, the cephalothorax;—*b*, the abdomen;—*p*, the palpi.

19. How do the female aranei'dæ take care of their eggs?
20. What are those white flocculi sometimes seen in foggy weather?
21. Are spiders venomous?
22. What are the characters of Mygales? What are the habits of Mason Spiders?

form one of the principal subdivisions of this family, have four pulmonary sacs. Some of them are of large size, and are known, in South America, among the French, under the name of *crab-spiders;* there is one, which, with the legs extended, covers a circular space of seven inches in diameter. They live on trees or among rocks. Other Mygales, much smaller, however, inhabit the South of France, and dig subterranean galleries in form of tubes, in dry and mountainous situations, the apertures to which are furnished with movable doors.

> "The mason spiders (*Mygale cæmentaria*) excavate for themselves subterranean caverns, in which these marauders lurk, secure from detection, even by the most watchful foe: nor could any robber's den, which ever existed in the wild regions of romance, boast more sure concealment from pursuit, or immunity from observation. The construction of these singular abodes has long excited the admiration of the naturalist: a deep pit is first dug by the spider, often to the depth of one or two feet, which, being carefully lined throughout with silken tapestry, affords a warm and ample lodging; the entrance to this excavation is carefully guarded by a lid or door, which moves upon a hinge, and accurately closes the mouth of the pit. In order to form the door in question, the Mygale first spins a web which exactly covers the mouth of the hole, but which is attached to the margin of the aperture by one point only of its circumference, this point of course forming the hinge. The spider then proceeds to lay upon the web a thin layer of soil collected in the neighbourhood of her dwelling, which she fastens with another layer of silk; layer after layer is thus laid on, until at length the door acquires sufficient strength and thickness: when perfected, the concealment afforded is complete; for, as the outer layer of the lid is formed of earth precisely similar to that which surrounds the hole, the strictest search will scarcely reveal to the most practised eye the retreat so singularly defended."—*T. Rymer Jones.*

The other Aranei'dæ never have more than two pulmonary sacs: a large number is known; they are subdivided into many tribes, which, in turn, are composed of many genera.

23. The *Ara'neæ sedenta'riæ*, or sedentary spiders, form one of these divisions. They are remarkable for their habit of remaining in their webs, and keeping in their snares or close by them, to surprise their prey, instead of going abroad in pursuit of food.

24. To this tribe belong the *spiders, properly so called* (*Ara'nea* or *Tegena'ria*), which live in the interior of our houses, in hedges, along the road-sides, &c., and weave a large, nearly horizontal web, at the upper part of which is a tube where they keep themselves perfectly at rest.

25. Other Aranei'dæ are wandering, and constitute the tribe of *Vagabun'dæ*. They make no web, but watch for their prey and

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23. How are sedentary spiders distinguished?
24. What are spiders, properly so called?
25. What is the taren'tula?

pounce upon it or seize it in its flight. A species of this group, the taren'tula (*Lycosa*) is very celebrated; it derives its name from being found near Tarentum, a city of Italy: it is common in all the warm parts of Europe, and in the opinion of the people, its poison produces death or serious consequences, which can only be dissipated by having recourse to music and dancing. But it is now known that the poison of this animal is not really dangerous to any thing but the insects upon which it feeds.

26. In the Family of Pedipalpi, there are four or eight pulmonary sacs, and the palpi are very large and terminated by pincers or claws, called *cheli'ceræ* (*c*). They have no spinnerets.

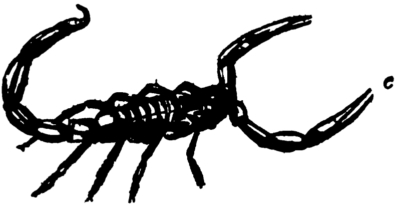

Fig. 58.—SCORPION.

27. The Scorpions—*Scorpio* (*fig.* 58)—belong to this family. They may be at once recognised by the abdomen, which is in form of a knotted tail, terminating in an arcuated, excessively acute point or sting. They inhabit the hot countries of both hemispheres, live on the ground, conceal themselves under stones and other bodies, most commonly in ruins, dark and cool places, and even in houses. They run with considerable swiftness, curving their tail over the back. They can turn it in every direction, and can use it in attack and defence. With their pincers they seize various insects, on which they feed, pierce them with their sting by directing it forwards, and then pass their prey through the cheli'ceræ and jaws. The wound produced by the sting of some species is followed by serious and alarming symptoms. The remedy employed is the volatile alkali, used both internally and externally.

ORDER OF ARACH'NIDA TRACHEA'RIA.

28. The Arach'nidans of this order are not provided with pulmonary sacs, but breathe by means of trach'eæ. The air penetrates into these canals through two very small stigmata, situated at the lower part of the abdomen. They all seem to be without a circulatory apparatus; some of them have no eyes, and those that possess them, never have more than two or four.

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26. How is the family of Pedipalpi characterized?
27. How are scorpions recognised? What are their habits?
How are the tracheal Arach'nidans characterized?

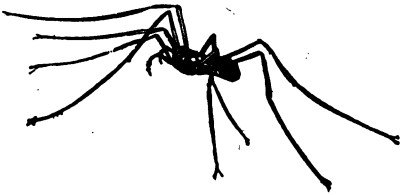

Fig. 59.—PHALANGIUM.

29. In this order are placed mites, the *mowers* (*phalan'gium*), &c., so remarkable for the length of their legs (*fig.* 59). Their mandibles are shorter than the body, and their eyes are borne on a common peduncle. They are very active; some live on the ground, and others on trees.

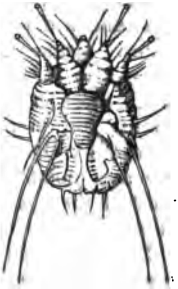

Fig. 60.—A'CARUS.

30. The tribe of ACA'RIDES or mites is composed entirely of very small or microscopic Arach'nidans. Their habits vary very much. Some live on the ground under stones, or on plants; others are aquatic; some are only found in organic substances, which are more or less changed, as old cheese, &c.; and there are some that live in the skin or flesh of different animals. A species of mite, the *leptus autumnalis*, very common in autumn on wheat and other plants, insinuates itself under the skin and occasions an almost insupportable itching. To one genus of mites, called *Sarcop'tes* (from the Greek, *sarx*, in the genitive, *sarkos*, flesh, and *koptein*, to cut), is due that loathsome disease the itch. This a'carus is represented (*fig.* 60) magnified. Other parasitic arach'nidans attach themselves to dogs, oxen, &c., and are known under the name of ticks, &c.

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29. What are mowers?

30. What are Aca'rides? What is the cause of itch? What are ticks?

LESSON VI.

Class of Crusta'cea.—*Organization — Moulting — Circulation—Respiration—Division.*

CLASS OF CRUSTA'CEA.

1. The class of Crusta'cea (from the Latin, *crusta*, a hard covering) comprises all articulated animals, that have articulated legs, and are provided with a heart, and branchiæ for breathing water. Crabs and cray-fish are types of this group; but we place also in it a great number of animals whose structure is much more complicated, and whose external form is very different; for, in proportion as we descend in the natural series formed by these creatures, we observe the same general plan becomes modified, and more and more simplified. The body in most of them is covered by a sort of crust of almost stony hardness.

2. Crusta'ceans differ greatly from anne'lidans, but resemble insects and arach'nidans by having white blood, and articulated legs; and are distinguished from the two last classes, by their branchial respiration, by the number of their legs, and by several other characters.

3. The body of crusta'ceans is composed of a succession of rings more or less distinct. Sometimes these segments move freely on each other, and at others they are so solidly joined that the rings are merely indicated by ridges. Frequently the head and thorax form but one piece, which is separated from the abdomen. In the lobster, for instance, the head and thorax are confounded in one mass, and the abdomen is composed of seven distinct and movable rings (*fig.* 61, *b*). It is the same in crabs, except that the abdomen is smaller, and folded underneath; but in the wood-louse, the head is distinct from the thorax, which is itself divided into seven movable rings. The legs, which are composed of several articulations, are inserted into the thorax: their number is ordinarily five or seven pairs; lobsters and crabs

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1. What description of animals constitute the class of Crusta'cea?
2. How are Crusta'ceans distinguished from Anne'lidans, insects and Arach'nidans?
3. How are Crusta'ceans characterized?

have five; but the wood-louse has seven pairs of legs. The head is provided in front with two pairs of appendages, called antennæ (*e*, *f*, *fig.* 61), and is also furnished with several pairs of jaws, and the abdomen bears other appendages in form of fins. An examination of the figure (61), which represents a lobster, will enable us better to understand the various parts of crusta'ceans:—*a*, the carapace, or common integument of the head and thorax; — *b*, the abdomen, composed of seven rings;—*c*, the caudal fin; — *d*, the eyes; — *e*, the internal antennæ; —*f*, the external antennæ;—*g*, the *palpi*, which are articulated filaments attached to the jaws or to the lower lip, and appear to be employed by the animal in recognising its food; — *h*, the first pair of legs, called *chelæ* (from the Greek, *chele*, pincers); — *i*, the second pair of legs, also terminated by pincers; —*j*, the third pair of legs, terminated by pincers, and termed foot-jaws; — *k*, the fourth pair; —*l*, the fifth pair of legs.

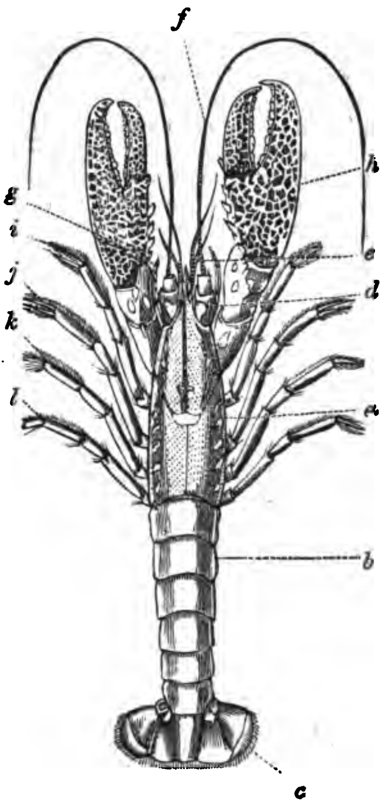

Fig. 61.—LOBSTER.

4. The external skeleton of crusta'ceans is formed of an extremely hard epidermis: at certain periods it is detached and falls off. The necessity for such changes or moulting in animals, whose body is enclosed in a hard sheath, is very plain; for inasmuch as this sheath does not grow or enlarge, like the internal parts, it would oppose an insurmountable obstacle to their develop-

4. What kind of skeleton do Crusta'ceans possess? Do they always preserve the same covering?

ment, if it did not fall off when it had become too small to conveniently accommodate them: therefore, crusta'ceans change their skin as long as they continue to grow, and it appears that most of these animals grow during their whole lives. The manner of getting rid of the old envelope is very curious. Generally they succeed without producing any deformity, and when they leave it, the surface of the whole body is already provided with a new sheath; but it is still soft, and becomes hard at the expiration of some days. Crabs which have recently cast their old shell or skin, and while the new skin remains soft, are considered a great delicacy.

"We are indebted to Reaumur, who watched the process in the cray-fish (*Astacus fluviatilis*), for what little is known concerning the mode in which the change of shell (in crustaceans) is effected. In the animal above mentioned, towards the commencement of autumn, the approaching moult is indicated by the retirement of the cray-fish into some secluded position, where it remains for some time without eating. While in this condition, the old shell becomes gradually detached from the surface of the body, and a new and soft cuticle is formed underneath it, accurately representing of course all the parts of the old covering which is to be removed; as yet, but little calcareous matter is deposited in the newly formed integument. The creature now becomes violently agitated, and by various contortions of its body seems to be employed in loosening thoroughly every part of its worn-out covering, from all connection with the recently secreted investment. This being accomplished, it remains to extricate itself from its imprisonment; an operation of some difficulty; and, when the nature of the armour to be removed is considered, we may well conceive that not a little exertion will be required before its completion. As soon as the old case of the cephalo-thorax has become quite detached from the cutis by the interposition of the newly formed epidermic layer, it is thrown off after great and violent exertion; the legs are then withdrawn from their cases after much struggling; and, to complete the process, the tail is ultimately by long continued efforts extricated from its calcareous covering, and the entire coat of mail which previously defended the body is discarded and left upon the sand. The phenomena which attend this renovation of the external skeleton are so unimaginable, that it is really extraordinary how little is accurately known concerning the nature of the operation. The first question which presents itself, is, how are the limbs liberated from their confinement? for, wonderful as it may appear, the joints even of the massive *chelæ* of the lobster do not separate from each other; but, notwithstanding the great size of some of the segments of the claw, and the slender dimensions of the joints that connect the different pieces, the cast-off skeleton of the limb presents exactly the same appearance as if it still encased the living member. The only way of explaining the circumstance, is to suppose that the individual pieces of the skeleton, as well as the soft articulations connecting them, split in a longitudinal direction, and that, after the abstraction of the limb, the fissured parts close again with so much accuracy that even the traces of the division are imperceptible."—*T. Rymer Jones.*

It is said that a lobster will throw off its claws if alarmed by the report of a cannon. This singular power of breaking off their own limbs, possessed by many crustaceans, is a very indispensable provision in their economy. Should the claw of a lobster, for example, be damaged by accidents to which creatures encased in such brittle armour must be perpetually exposed, the animal might bleed to death, if it did not at once break off the injured member at a particular point; namely, at a point in the second piece from the body; and by this operation, which seems to produce no pain, the bleeding is effectually staunched. After this extraordinary amputation has been effected, another leg begins to sprout from the stump, which soon grows to be an efficient substitute for the lost extremity, and gradually, though slowly, acquires the pristine form and dimensions of its predecessor. The process of reproduction is as follows: — the broken extremity of the second joint skins over, and presents a smooth vascular membrane, at first flat, but soon becoming conical as the limb begins to grow. As the growth advances, the shape of the new member becomes apparent, and constrictions appear, indicating the position of the articulation; but the whole remains unprotected by any hard covering, until the next change of the shell, after which it appears in a proper case, being, however, still considerably smaller than the corresponding claw on the opposite side of the body, although equally perfect in all its parts.

5. The nervous system of crusta'ceans is considerably developed: the ganglia of the head and thorax are large, and the latter are sometimes united in a single mass. Most of these animals have eyes of a very complicated structure. In general each one of these organs is composed of an assemblage of a multitude of little eyes, and the cornea covering each presents a considerable number of square or hexagonal *facets* corresponding with it. Sometimes these compound eyes are very slightly projecting, sometimes, on the contrary, they are placed at the end of two movable stems which are fixed on the front part of the head; by means of these peduncles or stems they can be directed forwards or thrown backwards, in a kind of orbit (as in crabs, *fig.* 63). In most crusta'ceans too, we observe an organ of hearing, which consists of a small tubercle, situated between the mouth and the base of the external antennæ, enclosing a small vesicle filled with water, and the termination of the acoustic nerve. From the stony nature of the skin, their sense of touch must be very obtuse.

6. The legs of crusta'ceans do not serve them for walking or swimming only; in general, the first pair terminate in a sort of pincers (called *chela*), by aid of which the animal seizes its prey (*fig.* 61).

7. Most of these animals are carnivorous; some are parasites, and live on other animals, whose blood they suck by means of a kind of trunk; but most of them feed on solid food, and have mouths armed with strong jaws, often numbering six pairs. The stomach is situated immediately under the mouth in the anterior part of the body (*fig.* 62, *e*); it is large, and its parietes are

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5. What is the character of the eyes in crusta'ceans? Have they an organ of hearing?

6. What is meant by chela?

7. Upon what do crusta'ceans feed?

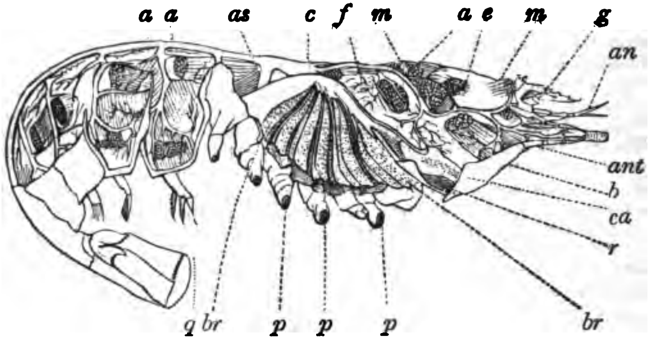

Fig. 62.—ANATOMY OF CRUSTACEANS—LOBSTER.

commonly supported by solid plates, and internally furnished with very hard teeth. The intestine is narrow, and on each side of this tube we see the liver (*f*), which is generally very voluminous; but sometimes we find simple biliary vessels substituted for it.

8. The heart of crusta'ceans (*c*) is situated near the back, about the middle of the thorax; it is generally of considerable size, and consists of one ventricle only, which forces the blood through the arteries. After having furnished nutritious material to the various organs, this liquid goes to the venous sinus placed along the base of the legs, thence to the respiratory organs (*br*), and then returns to the heart. The heart of crusta'ceans is aortic, and the circulation is carried on nearly in the same manner as in mollusks.

9. The respiration of crusta'ceans is almost always aquatic, and is effected by means of branchiæ (*br*). These organs vary both in form and situation; but they are generally attached near the base of the legs.

10. All crusta'ceans are ovi'parous; after laying her eggs, the

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Explanation of Fig. 62.—*Anatomy of Crusta'ceans.*—A lobster seen in profile, the greater part of the integuments being removed;—*c*, the heart;—*a*, *a*, the abdominal artery;—*as*, the sternal artery;—*a*, artery of the antennæ;—*e*, the stomach;—*m*, muscles of the stomach;—*f*, the liver;—*br*, branchiæ;—*p*, base or point of insertion of the legs;—*ca*, part of the carapace;—*b*, the mouth;—*r*, the respiratory canal destined to give passage to water for the purpose of respiration;—*g*, the eyes;—*an*, the superior antennæ;—*ant*, base of the inferior or second pair of antennæ;—*q*, the caudal fin, the principal organ of progression.

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8. What is the character of the circulation?
9. How do crusta'ceans breathe?
10. How are the young of crusta'ceans produced?

female carries them for a time suspended under the abdomen, or even enclosed in a kind of pouch formed of appendages of the legs; sometimes the young are born in this pouch, and remain in it until after they have undergone the first moult.

11. The Class of Crusta'cea is divided into three natural groups or divisions, according to the conformation of the mouth; namely,

1st. The *Trito'res* or Grinders, having the mouth furnished with jaws and mandibles proper for mastication.

2d. The *Sucto'ria* or Suckers, having a mouth provided with a tubular beak armed with suckers.

3d. The *Xi'phosura* (from the Greek, *xiphos*, a sword, and *oura*, tail), in which the mouth is destitute of the appendages properly belonging to it, but is surrounded by legs, the bases of which constitute the jaws.

12. The group of Trito'res or Grinders is divided into nine orders, and comprises most of the crusta'ceans. The principal orders are named *Decapoda*, *Iso'poda*, *Am'phipoda*, &c.

LESSON VII.

Crusta'ceans. Order of Decapoda—*its Division.*
Bra'chyu'ra.—*Crabs—Land-crabs—Habits.*
Anomou'ra.—*Soldier or Hermit-crabs.*
Macrou'ra.—*Craw-fishes—Lobsters—Locustæ—Prawns.*
Orders of Am'phipoda and Iso'poda.—*Sea-louse—Wood-louse—King-crab—Entomo'stracans—Trilobites.*
Class of Cirr'hopoda.—*Ana'tifa—Bala'nus.*

1. The order of Decapoda (from the Greek, *deca*, ten, and *pous*, foot) is so called, because the animals comprised in it have ten legs. These crusta'ceans (*fig.* 63) have the head and thorax confounded in one piece, and concealed under a kind of shield, called *carapace* (*fig.* 61, *a*). The eyes are borne on movable peduncles, and the branchiæ are situate on each side of the thorax, enclosed in particular cavities beneath the lateral parts of the carapace (*fig.* 62, *br*). The mouth is armed with six pairs of jaws; the first pair are named mandibles; the two next are jaws, properly so called; and the three last are termed foot jaws. In

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11. How is the class of Crusta'cea divided?
12. How is the group of Trito'res divided?
1. What are the characters of decapods?

some, the abdomen is very short, and folded beneath the thorax (*fig.* 63); while in others, this part of the body extends backwards, is of considerable size, and is a powerful organ of locomotion (*fig.* 61, *page* 69).

2. This order is divided into the *Macrou'ra* (from the Greek, *makros*, long, and *oura*, tail) or swimming decapods, which have a long abdomen terminated by a fin spread out like a fan (*fig.* 61, *c*); the *Bra'chyu'ra* (from the Greek, *brachus*, short, and *oura*, tail) or short-tailed species, of which the crab is a familiar specimen; and the *Anomou'ra* (from the Greek, *anomos*, nameless, irregular, and *oura*, tail), which inhabit the empty shells of mollusks.

3. The section of BRA'CHYU'RA consists of crusta'ceans, known under the common name of crabs; they are formed for running, rather than swimming. This section is divided into four families, each of which is composed of several tribes, subdivided in turn into a great many genera; they are esteemed as food. Most of them inhabit the sea. They run quickly along the shore; their legs are placed in such wise that they most easily move sideways, although they can advance in any direction. The first pair of legs are pincers or claws, and do not assist in locomotion.

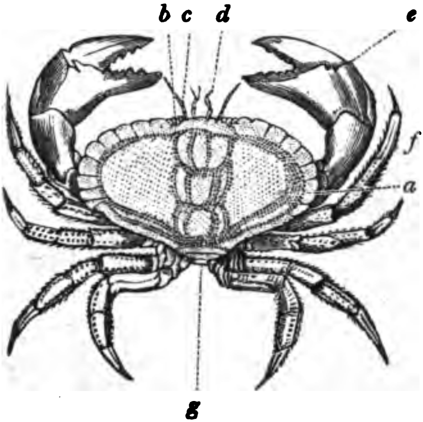

Fig. 63.—CRAB.

4. Among the common species, on the French coast, is one, sometimes known as the mad crab, *Cancer mænas*, from its manner of running; it is of moderate size, and the carapace is

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Explanation of Fig. 63.—A crab (*Cancer pagurus*);—*a*, the carapace;—*b*, the eyes;—*c*, the external antennæ;—*d*, the internal antennæ;—*e*, the chelæ or pincers;—*f*, second pair of legs;—*g*, the abdomen, folded beneath the thorax.

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2. How is the order of Decapoda divided?
3. What crusta'ceans are comprised in the section Bra'chyu'ra? How are crabs characterized?
4. How does the mad crab obtain its name?

greenish, which becomes red by boiling, as is the case with most crusta'ceans. Among the crabs, properly so called, is the *Cancer pagurus* (*fig.* 63), which is among the largest species; the carapace is somewhat oval, ten to twelve inches wide, of a reddish-brown colour, and festooned on the edges; its flesh is much esteemed. A group, named *Portunus* (from the Latin, *portus*, a haven or bay), is distinguished by the lamellar form of the last joint of the posterior legs; these crabs are essentially swimmers.

5. *Land-crabs — Gecarci'nus* (*fig.* 64) — inhabit the West Indies and other warm countries. These crabs, instead of living in the sea, as most crusta'ceans do, are essentially terrestrial, and they sometimes live at a considerable distance from the shore. They, nevertheless, avoid extremely dry situations, and are ordinarily found in marshy districts.— They all dig deep holes. They are commonly seen at night, or just after abundant rains, when they sally forth in crowds from their subterranean habitations in pursuit of food; some species live principally on vegetables; but others seek animal food with avidity; great numbers are found in cemeteries; and, it is said that, in the West Indies, they have been known to enter dissecting-rooms to feast on the dead.

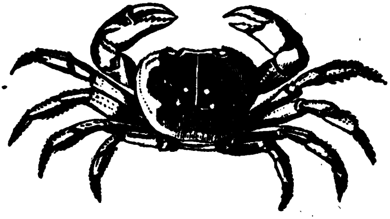

Fig. 64.—LAND-CRAB.

6. One of the most curious points in the history of these animals is that they make an annual journey to the sea-shore. In the rainy season they abandon their holes; they assemble in almost numberless troops, and, guided by an instinct which is incomprehensible to us, take a direct line towards the sea, although they are often very distant from it. They travel chiefly at night, and nothing but large rivers arrests or turns them from their route; they march over houses, scale rocks, and often destroy whole plantations, cutting and destroying the young plants as they pass along. Having reached the sea, these armies of crabs plunge in and bathe several times, and then retire to the plains or neighbouring woods. Sometime afterwards the females go again to the sea and there deposit their eggs; then they take up their march and return to their ordinary abode; but at this time they are so thin and feeble, they can scarcely drag themselves along.

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5. What are the characters of land-crabs?
6. What are the habits of land-crabs?

We find in Italy, Greece, and Egypt, another species of land-crab, which lives along the margins of rivulets, known to naturalists under the name of *Thelphu'sa fluviati'lis.*

7. The decapods of the section of ANOMOU'RA differ from each other widely in their organization. Although the abdomen or tail is not reduced to the rudimentary condition, as in the Bra'chyu'ra, it does not afford them great assistance in swimming. As their name imports, the Anomou'ra have tails of very unusual conformation; instead of being encased in a hard coat of mail, as in the lobster, the hinder part of the body is soft and leathery. This section includes many genera.

8. The *Soldier-crabs* or *Hermit-crabs* (*Pagurus*) are remarkable for their habits. They frequent sandy and level shores. They always take possession of empty turbinated shells of some gasteropod mollusk, in which they establish themselves, and we may readily conceive of the reason of this habit: the abdomen, instead of being hard and crusta'ceous, as in other animals of the same class, is always soft and membranous; therefore, to defend it from the attacks of their enemies and to preserve it from numerous accidents to which its softness exposes them, they need a kind of armour, which they find in the shells in which they lodge. When they have increased in size and find the dimensions of their dwelling too narrow, they take possession of a more voluminous shell; but, except for this purpose only, they never go out of the shell entirely, but always carry about with them their domicil, and on the approach of the smallest danger retire into it. It is said, that if we remove from their shells a number of these soldier-crabs, or pirates, as they are sometimes called, and leave the party only one or two of the same shells, they will fiercely dispute possession.

"The wonderful adaptation of all the limbs to a residence in such a dwelling cannot fail to strike the most incurious observer. The *chelæ*, or large claws, differ remarkably in size; so that, when the animal retires into its concealment, the smaller one may be entirely withdrawn, while the larger closes and guards the orifice. The two succeeding pairs of legs, unlike those of the lobster, are of great size and strength; and, instead of being terminated by pincers, end in strong pointed levers, whereby the animal can not only crawl, but drag after it its heavy habitation."

9. The decapods of the section of MACROU'RA are recognised at first sight by the great development of their abdomen, which always terminates in a large fin (*fig.* 61, *c*), composed of five

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7. How is the section Anomou'ra distinguished?
8. What are hermit-crabs?
9. How is the section Macrou'ra distinguished?

plates arranged like a fan. They are essentially swimmers, and never land; they never walk except at the bottom, under water; they swim almost constantly, and by striking the water with their powerful tail, dart forward with great rapidity. The body is elongated, and almost always laterally compressed; they have very long antennæ, and false natatory legs beneath the abdomen. This section of decapods is divided into four families: Cray or craw-fish, Lobsters, Locustæ, and Prawns.

10. Cray-fishes are distinguished from most other decapods by the conformation of their legs; those of the first pair terminate in very large chelæ or pincers; and those of the two succeeding pairs, although slender, also terminate in pincers. The carapace is a little elongated, and is not armed with spines, and its anterior extremity is always extended so as to form a kind of beak or projecting rostrum (*fig.* 65, *r*). These crusta'ceans are aquatic; some live in fresh water, and others inhabit the sea.

11. The *fresh-water cray-fish* (*Astacus fluviatilis*) is found in the fresh waters of most countries of Europe, and ordinarily keeps under stones. It feeds on mollusks, fishes, putrid flesh, &c. It is said to live more than twenty years; those found in running waters are most esteemed.

12. The *sea cray-fish* or *lobster*—*Astacus marinus* (*fig.* 61)—is much larger than the fresh-water or river cray-fish; like the locustæ, it frequents fissures among rocks. The American species is somewhat different from that of Europe. Lobsters are caught in traps, made of slats or osiers, baited, and then sunk by means of a weight; a buoy and cord are attached to draw up the trap for examination, at the proper time.

13. The locustæ (*Palinu'rus*) are the largest of all the decapods of this section. Their carapace is studded with a great number of spines, and terminated by two thick points curved forwards; the abdomen is very large; their legs are all terminated by a single toe; those of the first pair are strongest, but shorter than those of the second pair. These crusta'ceans inhabit almost every sea, and are sought as food. The *Palinu'rus quadricornis* is sometimes half a yard in length, and when loaded with ova weighs from twelve to fourteen pounds.

14. Prawns—*Palæmon* (*fig.* 65)—are small decapods, having an elongated, laterally compressed body; the legs are slender, and those of the two first pairs are terminated by little pincers,

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10. How are cray-fishes distinguished?
11. Do all cray-fishes live in salt water?
12. What are lobsters?
13. What are locustæ?
14. What are prawns?

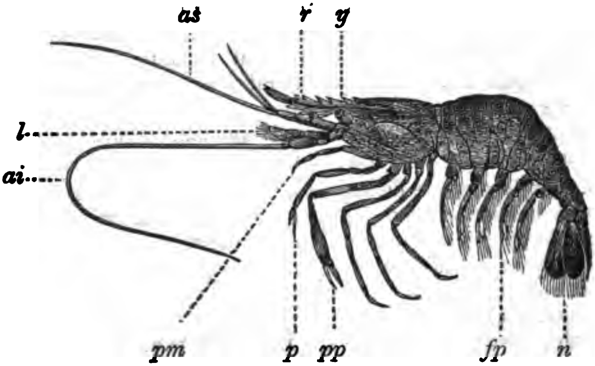


Fig. 65.—PALÆMON OR PRAWN.

the antennæ are very long, and the beak or rostrum is serrated, and very projecting. The flesh is very delicate and esteemed to be superior to that of shrimps.

15. Those crusta'ceans which compose the orders of AM'PHIPODA (from the Greek, *amphis*, on both sides, and *pous*, foot) and ISO'PODA (from the Greek, *isos*, equal, and *pous*, foot), do not, like the decapods, bear their eyes on movable peduncles, nor do they possess a carapace; their head is distinct, and the thorax is divided into seven rings. The Am'phipods breathe by vesicular appendages fixed under the thorax, near the base of the legs; and the Is'opods, by means of membranous lamellæ, which terminate the appendages attached to the abdomen.

Fig. 66.—TALITRA.

16. Among the Am'phipods are the *sea-lice*— *Talitra* (*fig.* 66)—small animals which often remain on shore after the fall of the tide, where they may be seen jumping with great activity.

Explanation of Fig. 65.—The Prawn or Palœmon:—*as*, first pair of antennæ;—*ai*, second or inferior pair of antennæ;—*l*, the lamellar appendage covering its base;—*r*, the rostrum;—*y*, the eyes;—*pm*, external foot-jaws;—*p*, first thoracic leg;—*pp*, second thoracic leg;—*fp*, false natatory legs of the abdomen;—*n*, caudal fin.

15. How are the orders of Am'phipoda and Iso'poda characterized?
16. What are sea-lice?

17. Most of the Iso'pods inhabit the sea, but there are some that live on land. To this order belongs the *wood-louse—Oniscus* (*fig*. 67)—which is commonly found in caves, beneath stones, and in other damp, shaded situations.

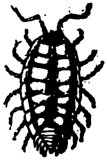


Fig. 67.
ONISCUS.

18. The *Sucto'ria*—the crusta'ceans of this division are parasites, and live on other animals; they have a mouth in form of a beak or cylindrical trunk, enclosing styliform appendages, suitable for piercing the integuments of those animals whose fluids they suck. They are generally found attached to fishes.

19. The division of crusta'ceans named XI'PHOSURA forms a single genus, Limulus or king-crab. They are large animals, having a body divided into two parts; the first part, which is covered by a semicircular shield or carapace, bears the eyes, the antennæ, and six pairs of legs which surround the mouth (*fig*. 68, *b*), and at the same time serve for progression and mastication, as well as for the prehension of food; the second part of the body, which is covered by an almost triangular shield, bears, underneath, five pairs of natatory legs, the posterior sides of which are furnished with branchiæ, and is terminated by a styliform tail. These singular animals are found in the Indian Ocean, and on our own

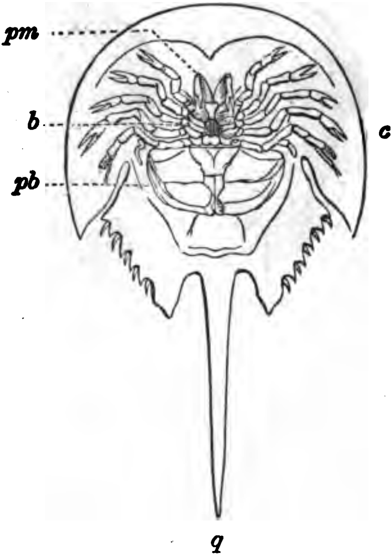


Fig. 68.—KING-CRAB--LIMULUS.

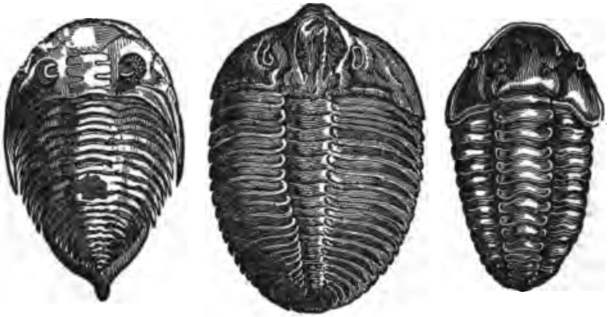
Explanation of Fig. 67.—A king-crab viewed from below: —*c*, the carapace;—*q*, the tail;—*b*, the mouth;—*pm*, legs which surround the mouth;—*pb*, the legs bearing branchiæ or gills.

17. What are wood-lice?
18. What are suctorial crusta'ceans?
19. What are king-crabs? How are they characterized?

coasts. On some parts of the coast of New Jersey they form an article of food for swine.

20. The *En'tomos'tracans* (from the Greek, *entomos*, incised, and *ostrakan*, a shell) are all extremely small, and most of them have a single eye placed in the middle of the front part of the animal. They abound in fresh waters.

21. To the class of Crusta'ceans also belong the *Tri'lobites*, a tribe of extinct animals found only in the fossil state; they would bear some resemblance to a very large oniscus or sea-louse, if the body of the latter were divided into three lobes by longitudinal grooves. Three species of trilobites are figured below (*fig*. 69).



Asaphus Caudatus. *Asaphus Buchii.* *Colymene Blumenbachii*

Fig. 69.

CLASS OF CIRRHOPODA OR CIRRIPEDA.

"However distinct in outward appearance, and even in their internal economy, the creatures composing the primary divisions of animated nature may seem to be when superficially examined, closer investigation invariably reveals to the zoologist gradations of structure connecting most dissimilar types of organization, and leading so insensibly from one to another, that the precise boundary line is not always easily defined. The Cirrhopods or *Barnacles* present a remarkable exemplification of this important fact."

22. The class of Cirrhopoda (from the Greek, *kirros*, a cirrus or curl, and *pous*, foot) is composed of animals, which, in many respects, especially as to their shells, resemble mollusks, but are

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20. What are en'tomos'tracans?
21. What are tri'lobites?
22. What are Cirrhopods? How are they characterized?

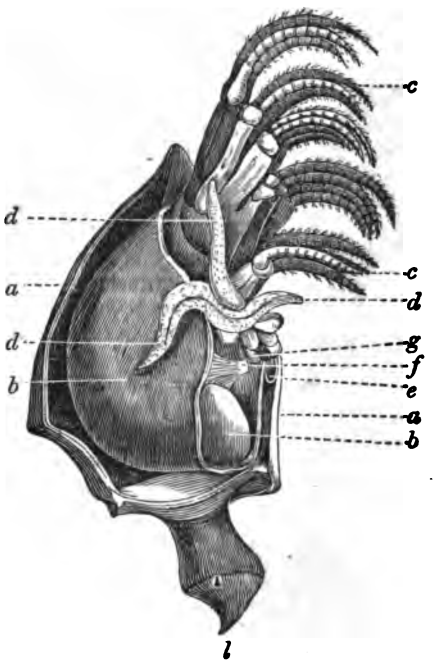

Fig. 70.—CIRRHOPOD OR CIRRIPED.

more closely allied to articulated animals. In the early period of their existence all these creatures are marine, and swim readily, and resemble, particularly in their organization, certain inferior crusta'ceans; but very soon after birth, they permanently attach themselves to some submarine body, and entirely change their form. In this manner they are fixed by the base. The body is more or less pyriform and doubled on itself, and is enclosed entirely, or in part, in a kind of shell composed of several pieces. They have no eyes, and the mouth is furnished with mandibles and jaws, closely resembling those of certain crusta'ceans; the abdominal face of the body is occupied by two rows of fleshy lobes, each one bearing two long horny appendages (*c*), armed with ciliæ, and composed of a multitude of little articulations, corresponding in a manner to the fins or feet found under the tail of several crusta'ceans. These arms or cirri, of which there are twelve pairs, are doubled on themselves, and the animal is constantly drawing them in and then protruding them through the opening of its sheath. The nervous system consists of a double series of ganglia, arranged like that of other articulated animals.

Explanation of Fig. 70.—A Pentalasmis or anatifa, represented with one-half the shelly covering removed to show the body:—*a*, *a*, shell;—*b*, *b*, the body, which is soft, enclosing the principal viscera;—*g*, the mouth, seen from the ventral aspect, the oral aperture appears to be raised on a prominent tubercle;—*d*, *d*, *d*, fleshy appendages which constitute the respiratory or branchial organs;—*c*, *c*, flexible arms, or cirri;—*f*, muscle for protruding the cirri through the slit of the mantle;—*l*, the pedicle or base by which the animal attaches itself to submarine bodies.

They have a heart, which is placed on the dorsal part of the body, and they breathe by branchiæ, the form of which varies.

23. The Cirrhopods are divided into two natural families: the ANATIFÆ, which are fixed by a long cylindrical peduncle, and the BALANI, which are without a similar peduncle.

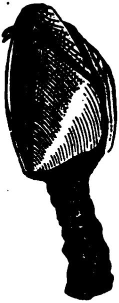

Fig. 71.
ANATIFA.

24. The Anatifæ, known in common parlance as barnacles (*figs.* 70 and 71), are enclosed in a sort of compressed mantle, open on one side, and suspended from a fleshy tube; sometimes this mantle is almost entirely cartilaginous, and is only furnished with two very small valves (as in the genus *Otion*); at other times, as in the genus ANATIFA, properly so called, it is covered by five testaceous plates, the two largest of which resemble those of a mussel. The branchiæ, which are in form of small pyramids, are attached to the base of the cirri. The common Anatifa inhabits the Atlantic Ocean, and is frequently found attached to rocks, the bottoms of ships, or pieces of floating timber. It was the subject of a most absurd fable; from some remote resemblance of its shell to a bird, it was supposed to give origin to a species of duck, and from this it has obtained the name Anatifa (from the Greek, *anas*, a duck).

Fig. 72.—GIANT BALANUS.

25. The Balani—*Balanus* (*fig.* 72)—abound on rocks in warm regions of the ocean, and are entirely contained in a very short, conical shell, attached firmly by the base, and composed of several pieces joined together; the opening of this tube is occupied by from two to four movable valves, between which we find a slit which gives passage to the cirri. The branchiæ are in form of membranous, foliated and fringed plates; they adhere to the internal face of a sort of mantle which lines the shell.

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23. How are Cirr'hopods divided?
24. What are the characters of Ana'tifæ?
25. What are the characters of Bala'ni?

LESSON VIII.

Class of Anne'lida. — *Organization — Division — Earthworms.*
Family of Sucto'ria.—*Leech.*
Order of Dorsibranchia'ta.—*Eunice.*
Order of Tubicola.—*Sabella.*

CLASS OF ANNELIDA.*

The lowest class of articulated animals comprehends an extensive series of creatures generally grouped together under the common name of *worms.*

1. The class of anne'lidans is composed of *red-blooded worms*, and is easily distinguished from the rest of the Branch of articulated animals by the *absence of articulated extremities.*

2. The body of these animals is considerably elongated, and generally slender (*figs.* 76 and 79); it is composed of a succession of numerous rings, the first of which, although it differs but little from the others, may be called the head; it contains the mouth, which is sometimes armed with a formidable apparatus of jaws. The skin has little consistence, and the rings formed by it are never horny nor stony. Many anne'lidans are entirely without legs, an example of which is seen in the leech (*fig.* 76); and when these organs do exist, they are never formed of solid pieces, articulated end to end, as in insects, crusta'ceans, and arach'nidans; they are merely fleshy tubercles, armed with stiff setæ or movable bristles, and are arranged in pairs on each side of the body, and are commonly found on each ring. The figure (73) on the next page, represents a transverse section of an anne'lidan, and conveys an idea of the character of the extremities of these animals;—*d*, is the dorsal arch of the ring;—*v*, the ventral arch;—*rv*, an extremity of the ventral arch;—*rd*, an extremity of the dorsal arch;—*s*, setæ or bristles, surrounding the appendage, called *cirrus* (*e*). The Eunice (*fig.* 79), a marine worm often found on oysters, is an example of an animal having extremities of this kind.

3. The nervous system consists of a long series of minute

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* From the Latin, *annulus*, a little ring.

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1. How are anne'lidans distinguished from other articulated animals?
2. How are anne'lidans characterized?
3. What is the character of their nervous system?

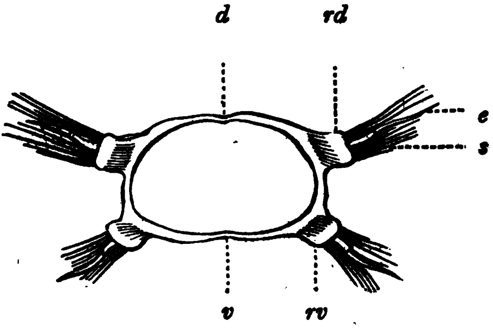

Fig. 73.—SECTION OF AN ANNELIDAN.

ganglia; there is a pair of ganglia in each ring, which circumstance may account for the curious fact, that when, in some instances, a part of a worm is cut off, both parts still live.

4. Most anne'lidans have, at the anterior extremity of the body, black spots which appear to be eyes of a very simple structure: they never possess distinct organs of smell or of hearing; but they often bear on the head, or on each side of the neck, filaments called antennæ and tentacles, which seem to serve them as organs of touch. In general these animals move by crawling, and assist themselves in progression by the setæ with which they are armed, but they are never swift: many live buried in the earth, or are enclosed in solid tubes which they never leave. Most of them inhabit the sea.

5. The digestive apparatus of anne'lidans is not particularly remarkable, except for the sucker (*tr*, *fig.* 74) with which the mouth in many of them is furnished; some have a long projectile trunk, and they are often provided with small horny jaws. They all appear to be carni'vorous.

6. The blood of anne'lidans differs from that of all other invertebrate animals by its red colour; it circulates in a complete system of arteries and veins, and often, it appears to be set in motion by several fleshy ventricles which may be regarded as hearts (*fig.* 74, *c*).

7. Almost all these animals live in water; they breathe by the skin, or through branchiæ (*br*), which resemble little packets of fringe, attached along each side of the back.

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4. In what organs of sense are anne'lidans deficient?
5. What is the character of the digestive apparatus?
6. What is the peculiarity of the blood in anne'lidans?
7. How do anne'lidans breathe?

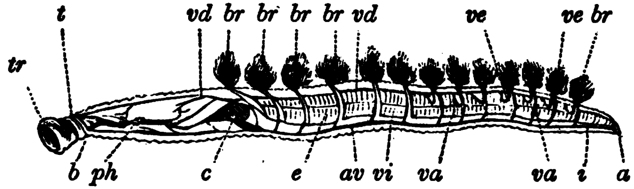

Fig. 74.—ANATOMY OF ANNELIDANS.

8. According to the differences in their respiratory organs, this class is divided into three orders; namely,

1st. The *abranchiate anne'lidans* (from the Greek, *a*, without, and *bragchos*, *branchia*, or gills), in which there is no visible respiratory apparatus.

2d. The *dorsibranchiate anne'lidans* (from the Latin, *dorsum*, back, and *branchiæ*, gills), in which the branchiæ are arranged along the middle or on each side of the back, in form of vascular tufts, fringes, &c. (*fig.* 74, *br*).

3d. The *tubicola*—tubicole anne'lidans (from the Latin, *tubus*, a tube, and *colo*, I inhabit) inhabit a fixed and permanent residence, which encloses and defends them. The two preceding orders are erratic. The branchiæ are in form of plumes or branches attached to the anterior part of the body (*fig.* 80).

9. The *abran'chia*—this order comprehends two very distinct families: the terricola *setigerous abran'chiate anne'lidans*, which have the body furnished with setæ (*bristles*), serving them for locomotion, and the *sucto'ria* or *suctorial abran'chiate anne'lidans*, which are without setæ, but have a prehensile sucker attached to each extremity of the body.

10. To the family of terrico'la (from the Latin, *terra*, earth, and *colo*, I inhabit) belongs the *lumbricus* or earth-worm, so common in our gardens. The body of these animals is cylindrical, elongated, and divided by plaits into a great many rings, and they are totally destitute of legs; in place of them, we find on

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Explanation of Fig. 74.—Anatomy of anne'lidans — longitudinal section of an Arenicola;—*t*, the cephalic extremity;—*b*, the mouth;—*tr*, the trunk or sucker;—*ph*, the pharynx;—*e*, the stomach; — *i*, the intestine; — *a*, the anus;—*br*, the branchiæ;—*c*, one of the ventricles serving as a heart;—*vv*, ventral vessel; — *va*, vessels which carry the blood to the branchiæ; — *ve*, vessels which bring the blood back from the branchiæ to the interior;—*vd*, dorsal vessel into which many of these last vessels empty;—*vi*, inferior intestinal vessel, which also receives vessels coming from the branchiæ; it opens in the dorsal vessel near the heart.

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8. How is the class of anne'lidans divided?
9. How are anne'lidans of the order abran'chia characterized?
10. What are the characters of the earth-worm?

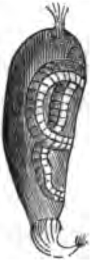

Fig. 75.
EGG OF THE EARTH-WORM.

each side a number of setæ which serve them for locomotion. They have neither eyes, tentacles, nor jaws. If we cut one of these into two pieces, each piece continues to live, and becomes a perfect animal; the part of the body which is deficient is reproduced.

11. The *lumbrici* (earth-worms) are propagated by eggs, which, when laid, are two or three lines in length. In the annexed figure (75), one of them, enclosing a mature embryo, is delineated; the top is closed by a peculiar valve-like structure, adapted to facilitate the escape of the worm. The egg commonly has a double yolk, and a couple of young ones are produced generally from each egg.

"Whoever has attentively watched the operations of an earth-worm, when busied in burying itself in the earth, must have been struck with the seeming disproportion between the laborious employment in which it is perpetually engaged, and the means provided for enabling it to overcome difficulties apparently insurmountable by any animal unless provided with limbs of extraordinary construction, and possessed of enormous muscular power. In the mole and burrowing cricket we at once recognise in the immense development of the anterior legs a provision for digging, admirably adapted to their subterranean habits." Every ring of the lumbricus, "when examined attentively, is found to support a series of sharp, retractile spines or prickles; these, indeed, are so minute in the earth-worm, that on passing the hand along the body from the head backwards, their presence is scarcely to be detected by the touch, but they are easily felt by rubbing the animal in the opposite direction; a circumstance which arises from their hooked form, and from their points being all turned towards the tail." By the aid of these the animal makes its way in the following manner: "The attenuated rings in the neighbourhood of the mouth are first insinuated between the particles of the earth, which, from their conical shape, they penetrate like a sharp wedge; in this position they are firmly retained by the numerous recurved spines appended to the different segments; the hinder parts of the body are then drawn forwards by a longitudinal contraction of the whole animal; a movement which not only prepares the creature for advancing further into the soil, but by swelling out the anterior segments forcibly dilates the passage into which the head had been already thrust: the spines on the hinder rings then take a firm hold upon the sides of the hole thus formed, and, preventing any retrograde movement, the head is again forced forward through the yielding mould, so that, by a repetition of the process, the animal is able to advance with the greatest apparent ease through substances which would at first seem utterly impossible for so helpless a being to penetrate."—*Thomas Rymer Jones—Comparative Anatomy.*

12. The family of *sucto'ria* or suckers comprises the leech, and all anne'lides that are unprovided with setæ. The integuments are soft; the body is generally oblong, slightly depressed,

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11. How are earth-worms propagated?
12. How is the family of Sucto'ria characterized?

and divided into a great many segments: it is entirely without legs or setæ, but has at either extremity, a dilatable, prehensile cavity, which performs the functions of a cupping-glass.—The mouth, situated at the bottom of the anterior or oral sucker (*fig.* 76, *a*), has neither trunk nor tentacle, but is armed with hard parts which serve the purposes of jaws. It has a certain number of eyes, or rather ocellar points, situated on the dorsal face of the anterior extremity of the body. The anus is placed at the bottom of the posterior sucker (*b*).

Fig. 76.
LEECH.

13. All these anne'lides feed at the expense of other animals. They attach themselves to fishes or batrachians; sometimes they devour mollusks, anne'lidans, or the larvæ of insects; certain species attach themselves to horses and cattle, and even to men, when they drink at springs; sometimes fixing themselves under the tongue, in the nostrils, or even in the gullet.

The mouth of a leech is an exceedingly perfect apparatus. "Around the entrance of the œsophagus are disposed three minute cartilaginous teeth, imbedded in a strong circle of muscular fibres. Each tooth has somewhat of a semicircular form, and, when accurately examined with a microscope, is found to have its free margin surmounted with minute denticulations so as to resemble a small semicircular saw (*fig.* 77). On watching a leech attentively during the process of biting, the action of these teeth is at once evident; for, as the skin to which the sucker is adherent is rendered quite tense, the sharp serrated edges of the teeth are pressed firmly against it, and, a sawing movement being given to each cartilaginous piece by the strong contractions of the muscular fibres around the neck, these instruments soon pierce the cutis to a considerable depth, and lay open the cutaneous vessels, from which the creature sucks the fluid which its instinct prompts it to seek after with so much voracity. The position of the teeth around the opening of the mouth, as represented in the annexed figure (78), will at once explain the cause of the tri-radiate form of the incision which a leech-bite invariably exhibits."—*T. Rymer Jones.*

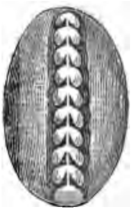

Fig. 77.
TOOTH OF A LEECH.

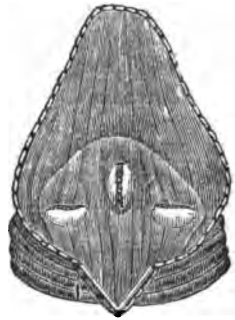

Fig. 78.
HEAD OF A LEECH MAGNIFIED.

The use of leeches is so general in the practice of medicine, that they have become an important object in commerce. They are imported from Spain, Portugal, and other countries

13. What are the habits of sucking Anne'lidans?

in Europe. They are preserved for a long time by packing them in moist earth or mud. On the approach of cold weather, they bury themselves in mud at the bottom of ponds, and pass the winter in a state of lethargy, and regain their activity in the spring.

14. The ORDER OF DORSIBRANCHIATA or erratic Annelidans are the most complicated in their organization of all animals of this class. The head is almost always distinct from the body, and is provided with a certain number of antennæ; we see there also one or two pairs of eyes, in form of black or variously coloured spots (*fig.* 79). The mouth is provided with a protractile trunk, the length of which is sometimes very considerable, and at its extremity we often find two or more pairs of horny jaws. Generally, on each side of the neck there is a certain number of tentacular cirri, appendages analogous to antennæ, and each ring has attached to it a pair of legs, varying in structure in the different genera: they are often composed, each of two tubercles, one placed on the dorsal, and the other on the ventral arch of the ring, and studded on top with a packet of setæ. Nothing can exceed the splendour of the colours which ornament some of these fasciculi of hairs; they yield, indeed, in no respect to the most gorgeous tints of tropical birds or the brilliant decorations of insects: green, yellow, and orange,—blue, purple, and scarlet,—all the hues of the rainbow play upon them with the changing light, and shine with the metallic effulgence only comparable to that which adorns the breast of the humming-bird.

Fig. 79.
EUNICE.

15. These anne'lidans walk and swim very well, but nevertheless, commonly live under stones, among shells, or buried in the sand; a kind of mucus which exudes from them forms a tubular sheath which they inhabit. They all live in the sea.

The ARENICOLA, the APHRO'DITA, the EU'NICE, &c., are some of the genera.

16. The ORDER OF TUBICOLA comprises anne'lides which have no distinct head, nor jaws, nor eyes, nor antennæ, but the anterior extremity of the body is furnished with a great number of appendages, some of which constitute bran'chiæ, and others for the prehension of food, or for locomotion. Their legs are but slightly projecting, and only assist them in rising or descending in the

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14. What are the characters of dorsibranch anne'lidans?
15. What are the habits of dorsibranch anne'lidans?
16. How is the order of Tubicola characterized?

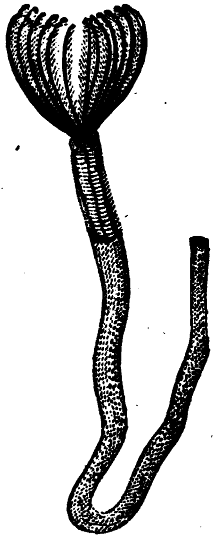

Fig. 80.—SABELLA.

tube they inhabit; most of them neither walk nor swim, and those that drag themselves along, do it by the assistance of the long tentacles surrounding the mouth. The tube varies in texture, in different species. Sometimes it is formed by agglutinating foreign substances, such as grains of sand, small shells, or fragments of various materials, by means of a secretion, which exudes from the surface of the body, and hardens into a tough membranous substance, as is the case of *Terebella medusa*, which constructs its tube by cementing together minute shells, and other small bodies. There is no muscular connection between these animals and the tubes they inhabit, so that the creature can be readily withdrawn from its residence.

17. In this order are placed the SERPULÆ, which live in calcareous tubes, variously contorted; the anterior extremity of the body is adorned by a crown of appendages like plumes: these animals are found adhering to oysters and other mollusks. They are frequently found encrusting the surface of stones, or other bodies, which have been immersed for any length of time, at the bottom of the sea; they are closed at one end, and from the opposite extremity the head of the worm is occasionally protruded in search of nourishment. The SABELLÆ also belong to this order. They inhabit a tube, which is most commonly composed of granules of clay or mud, and is rarely calcareous (*fig.* 80). The Dentalium, Terebella, Amphitrite, and Syphostoma, are other genera of the order of Tubicola.

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17. What are serpulæ? What are sabellæ?

FOURTH BRANCH OF THE ANIMAL KINGDOM.

ZO'OPHYTES OR RADIATA.

LESSON IX.

Zo'ophytes.—*Organization—Division.*
Class of Infuso'ria Rotato'ria.
Class of Entozo'a. — *Division — Filia'ria — Asca'rides — Tæ'nia.*
Class of Infuso'ria Polygas'trica.
Class of Echinoder'mata.—*Sea-stars.*
Class of Acale'pha.—*Medusa.*
Class of Polypi.—*Coral — Coral-reefs—Hydra — Sponges.— Geographical Distribution of the Animal Kingdom.*

The animals placed in the fourth and last great division of the animal kingdom possess an organization much less complicated and consequently much less perfect than that of the creatures we have studied in the preceding parts of our series.

1. In the higher animals the body always consists of two similar halves; all the external organs are arranged on each side of the middle line, in pairs; whenever there is an organ on one side, a similar one is found on the opposite side, and the superior and inferior surfaces of the body differ from each other. In Zo'ophytes, on the contrary, this symmetry is seldom found: in general, the different organs are placed around the axis or centre of the body, so as to give it a radiated form. Sometimes this arrangement is carried so far that the animal resembles a star (*fig.* 85); and in a great many of these creatures, the body resembles an expanded flower (*figs.* 87 and 88). Many of them live fixed at the bottom of the sea, and united to each other in such a manner as to wear the appearance of branching shrubs, and this external analogy to certain plants is so great, that for a long time these animals were confounded with marine plants, and even now that we know how much their structure, as well as their functions, differ from those of vegetables, we cannot assign to them a more appropriate name than *Zo'ophytes* (from the Greek, *zôon*, animal, and *phuton*, plant) or plant-animals.

2. In these animals the nervous system is entirely wanting, or is found in an extremely rudimentary state: they have no special

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1. What are the general characters of Radiate animals?
2. What is the character of the nervous system in Zo'ophytes?

organs of the senses, except perhaps their tentacles, which may serve them for the sense of touch.

3. Most Zoophytes are also destitute of blood-vessels, and they have no special organs of respiration, this function being performed by the whole surface of the body. Some of them have a mouth armed with teeth, a digestive canal and anus; but in others, the digestive cavity has a single opening, which serves at the same time both for mouth and anus.

4. This Branch of the animal kingdom is divided into six classes; namely, *Infuso'ria rotato'ria*, *Entozo'a*, *Infuso'ria polygas'trica*, *Echinoder'mata*, *Acale'pha*, and *Polypi*.

CLASS OF INFUSO'RIA ROTATO'RIA.

5. These creatures are so extremely small, that prior to the discovery of the microscope, their existence was not even suspected, and yet their structure appears to be as complicated as any other animal of the same branch. Although the instruments by means of which they were observed, caused them to appear to be two or three hundred times larger than they really are, no distinct organ was discovered in them, and for a long time they were regarded as creatures composed of a kind of animated jelly only, which lived by imbibition. But the researches of some modern naturalists, especially Professor Ehrenburg, of Berlin, have shown how much we were mistaken in regard to these animalcules; and we are astonished, not by the simplicity of their structure, but by their complicated microscopic organization.

6. These animalcules are found in stagnant waters, and also in water in which animal substances have been soaked. Their body is partially trans-

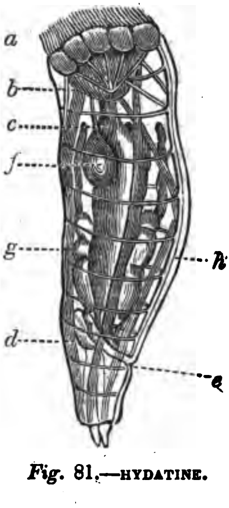

Fig. 81.—HYDATINE.

Explanation of Fig. 81.—Anatomy of a Hydatine, a microscopic animalcule, resembling a rotifer:—*a*, the vibratory cilia;—*b*, a fleshy mass which surrounds the mouth and sets the jaws in motion;—*c*, the stomach;—*d*, cloaca;—*e*, anus;—*f*, salivary glands;—*g*, ovaries;—*h*, vessels.

3. How do Zoophytes breathe?
4. How is the Branch of Zoophytes divided?
5. What are the characters of the rotatory Infuso'ria?
6. Where are these animalcules found?

parent, and frequently presents traces of annular divisions. The mouth occupies its anterior extremity, and on each side, or around it, are seen the vibratory ciliæ (*fig.* 81, *a*), the rotatory movements of which are very remarkable. The mouth is furnished with powerful muscles and lateral jaws. The digestive canal extends from one end of the body to the other, and ordinarily has an enlargement near the middle which constitutes the stomach (*c*); on each side of this tube are frequently seen bodies of a glandular appearance, and at its posterior extremity a sort of cloaca into which the oviducts empty.

CLASS OF ENTOZO'A.

7. This division comprises intestinal worms and other inferior animals of similar organization. Intestinal worms bear a closer resemblance to anne'lidans than to ordinary radiate animals. The body is elongated and composed of more or less distinct rings; there is often a digestive canal, sometimes vessels, but never a distinct circulation or special organs of respiration.

8. Most of these singular creatures can live only in the bodies of other animals, and lodge themselves in the substance of the liver, in the eyes, in the cellular tissue, in the muscles, and even in the brain, as well as in the alimentary canal; we know they are multiplied by means of eggs, and also that their young are in some instances born alive, but we do not understand by what means they are transmitted from one animal to another, nor how they penetrate into the substance of organs in which they are developed. There is scarcely an animal that does not nourish many kinds of them, and those found in one species are rarely found in many others.

9. This class is divided into two orders: one in which the intestinal canal floats free in the cavity of the abdomen, and therefore denominated *cavita'ria;* the other is named *parenchy'mata*, because the animalcules of this order have neither abdomen nor intestine distinct from the neighbouring parts, their digestive cavity consisting of ramified canals hollowed out in the substance of the body, and generally opening externally by suckers.

10. To the first division belong the FILIA'RIÆ; they have a slender, filiform body; several species are known, which live in the substance of the organs of many animals. One of these is the *Guinea-worm;* it lodges itself beneath the skin of man, and

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7. What description of animals belong to the class of Entozo'a?
8. Where are these animals found?
9. How is the class of Entozo'a divided?
10. What are filia'riæ? What are asca'rides?

is very common in warm countries. Asca'rides, which are found in the intestines of man, also belong to this division. One species, the *lum'bricus*, sometimes attains to fifteen inches in length.

11. To the second division, *parenchy'mata*, belongs the tape-worm (*Tæ'nia*). The body is terminated anteriorly by a small head (*fig.* 83, *a*), having two or four pits, and, frequently, one or more proboscis-like appendages; but the mouth is very indistinct, and the digestive apparatus is generally reduced to a double longitudinal vessel (*fig.* 82). The body is ordinarily flat, very long, and divided into a great many more or less distinct joints (*fig.* 83). Each segment or ring has one or two pores which communicate with the longitudinal vessels, and contains a dis-

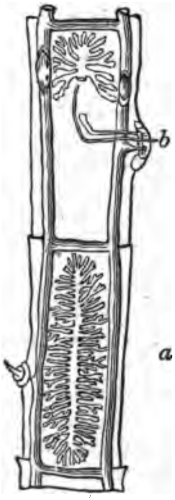

Fig. 82.

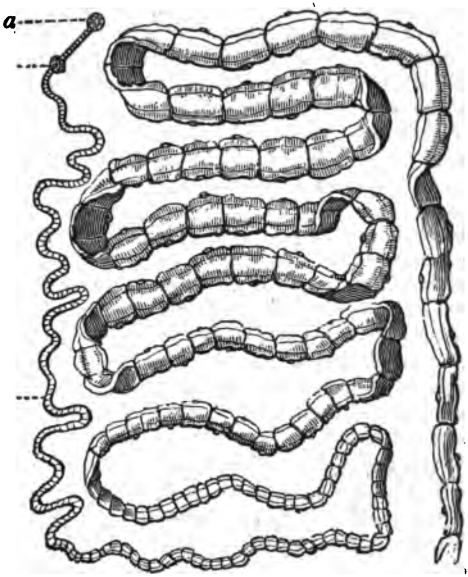

Fig. 83.—TÆNIA—TAPE-WORM.

Explanation of Fig. 82.—A ring or segment of a tænia, magnified, showing the ovaries;—*a*, the two longitudinal vessels and the lateral pore;—*b*, a segment from which almost the whole ovary has been removed.

Explanation of Fig. 83.—Represents the ribbon-like body of the tape-worm and the lateral vessels running through its whole length on each side;—*a*, the head.

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11. How are tape-worms characterized? Where are they found?

tinct ovary (*fig*. 82, *a*). The body of this creature consists of a great number of these segments, united together in a linear series (*fig*. 83): the segments which immediately succeed to the head (*a*) are very small, and so fragile that it is rarely this part of the animal is procured in a perfect state; they gradually however increase in size towards the middle of the body. Each segment of the tape-worm may be regarded as a distinct animal, for it possesses the means of reproducing itself; yet the alimentary tubes are common to them all, those of each joint freely communicating with the nutritive canals of the adjoining segments. The first joint of the Tæ'nia, which may be called its head, differs materially in structure from all the rest; it is in fact converted into an apparatus by means of which the entire animal derives its nourishment. This part, when highly magnified, is found to be somewhat of a square shape; in the centre is seen the mouth, surrounded with a circle of minute spines, so disposed as to secure its retention in a position for imbibing the chyle in which it is immersed. Around this mouth are placed four suckers. Tape-worms infest all classes of animals, and commonly inhabit the small intestine. Their presence in the alimentary canal generally causes debility and wasting of the body, and often very serious disturbance. The species which attacks man, "the solitary worm," is very difficult to get rid of.

We also place in this division certain very singular animals, which resemble a little bladder filled with water; they grow in different parts of the bodies of animals, and are called *Hydatids*. They are the cause of considerable disturbance and serious diseases.

12. **Infuso'ria Polygas'trica.**—These animalcules can only be perceived by means of the microscope; they are abundantly developed in water containing the remains of organic bodies;

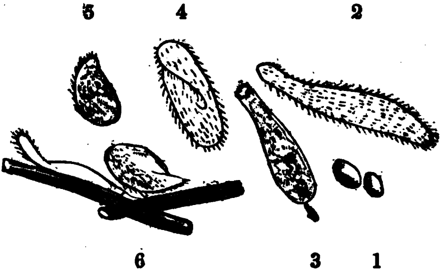

Fig. 84.—POLYAGASTRIC INFUSORIA.

12. What are the characters of the polygastric infuso'ria?

until within a few years they were confounded with the infuso'ria rotato'ria, the structure of which is very different. Their body, sometimes round, sometimes long and flat, is often covered with little ciliæ, and contains ordinarily a considerable number of cavities, which seem to discharge the functions of so many stomachs. The above figure will give an idea of the most common species of these creatures. The movements of the polygastrica, when seen under the microscope, are exceedingly vivacious; and although many of them inhabit a space not larger than the point of a needle, they swim about with great activity, avoiding each other as they pass in their rapid dance, and evidently directing their motions with wonderful precision and accuracy.

13. The **ECHINODER'MATA** or Echi'noderms (from the Greek, *echinus*, a hedge-hog, and *derma*, skin) are formed for crawling at the bottom of the sea, and are ordinarily provided with a multitude of retractile appendages, by means of which they attach themselves to bodies they touch; in general the skin is covered with spines, and their organization is more complicated than that of most Zoophytes. They often possess a kind of skeleton, vessels for circulation, special organs for respiration, and a separate intestinal canal furnished with two openings.

14. The *sea-stars — Asteria* (*fig*. 85)—belong to this division. Also, the sea hedge-hogs or sea eggs, which have the appearance of balls covered with spines; in some ports of the Mediterranean they are used for food.

Fig. 85.—SEA-STAR.

15. The **ACALE'PHA** or Acale'phans (from the Greek, *acalephe*, a nettle), commonly called *sea-nettles*, on account of the irritation contact with them produces on the skin, are of a gelatinous consistence; they always float on the sea, and are essentially organized for swimming. Their organization is very simple;

Explanation of Fig. 84.—Infu'soria polygas'trica as seen under a microscope;—1, monad;—2, trachelius anas;—3, enchelis or flask animalcule;—4, paramecium;—5, kolpoda;—6, trachelius fasciolarius as seen walking on microscopic plants.

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13. What are the characters of echi'noderms?
14. What are sea-stars?
15. How are acale'phans characterized? What are the characters of medusæ?

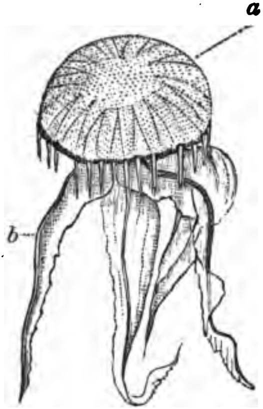

Fig. 86.—MEDUSA.

their internal organs consist almost exclusively of a stomach, hollowed in the substance of the body, from which arise different branched canals. The *Medusæ* belong to this class. The body is broad, and more or less convex, resembling a disk or the cap of a mushroom (*fig.* 86, *a*). The margin and centre of the cap are furnished with tentacles (*b*), which probably serve them to seize small mollusks or zoophytes, and convey them to the mouth. They swim by slowly contracting the margin of the cap, and thus expelling the water contained in its concavity; they are seldom seen on the surface except in calm weather. Many of these animals contribute to the phosphorescence of the sea, diffusing a whitish light.

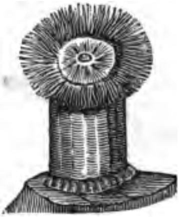

Fig. 87.—ACTINIA.

16. CLASS OF POLYPI.—Under the name of polypi is included a great number of animals, possessing a cylindrical or oval body, with an opening at one of its extremities, surrounded by long tentacles (*fig.* 87). The structure of polypi is very simple, and their faculties very limited. Most of them live fixed to other bodies, by the posterior extremity, and all their movement consists in extending and contracting their tentacles, and drawing the anterior portion of the body into itself. They are multiplied in two ways: sometimes they produce eggs, which detach themselves, and are expelled, and their development is left to chance; at other times, buds spring from the surface of the body, which never separate, but become so many new

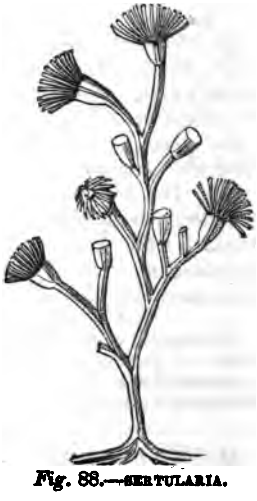

Fig. 88.—SERTULARIA.

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16. What are polypi? What are their characters?

polypi, similar to the parent; hence result masses of various form, in which an entire series of generations are aggregated, and seem to possess a life in common, just as if it were really a compound creature, provided with a single body, possessing a thousand mouths, and as many stomachs (*fig.* 88). In general the digestive cavities of all these aggregated animals, living thus in society, do not open directly into each other, but commonly there are vascular communications between the individuals united in a single mass, and the alimentary matter digested by one may in this way be of advantage to all its neighbours.

17. Frequently the bodies of these little animalcules is composed entirely of a semi-transparent tissue of extreme delicacy; but in most of them the inferior portion of the tegumentary sheath becomes much indurated, and even ossified so as to acquire the hardness and appearance of stone. This solid envelop assumes various forms, and sometimes constitutes tubes, and sometimes merely cells; for a long time it was considered merely as the dwellings of the polyps which formed it, and is designated under the name of *coral.* Sometimes every polyp has a distinct coral, but ordinarily it is the portion common to an aggregated mass of polyps that possesses the characteristics of these bodies, the volume of which may become enormous, although each of the parts forming it is extremely small.

18. It is in this way that polyps of only a few inches in length raise reefs and islands in seas bordering the tropics; when placed under circumstances favourable to their development, certain animals of this class multiply to such a degree as to cover chains of rocks or immense submarine banks, and form, with their stony *corals* heaped one upon another, masses whose extent is constantly increasing by the birth of new animalcules added to those already existing. The solid slough or remnant of each colony of polyps remains after the frail architects have perished, and serves as a base for the development of other polyps, until these living reefs reach the surface of the water, where these animals cease to exist, and the soil formed by their remains ceases to rise; but the surface of these masses of corals, exposed to the action of the atmosphere, becomes the site of a new series of phenomena; seeds, which are deposited by the winds, or borne thither by the waves, germinate, and the surface of these coral masses is in this way gradually clothed in a rich vegetation; and thus, what were but recently vast charnel-houses of almost microscopic zoöphytes, are converted into habitable islands. In the Pacific Ocean there are innumerable reefs and islands which had no other origin; in general they seem to be based on the crater

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17. What is coral?
18. How are coral reefs formed?

of some extinct volcano, for they are almost always of a circular form, with a lake in the centre communicating with the ocean by a single channel: some are more than ten leagues in diameter.

19. Almost all polyps inhabit the sea: some, however, are found in fresh water. Most polyps secrete this stony matter, above mentioned, in the cells of which they are lodged, or around which they are grouped. The stony matter, of a beautiful red colour, employed as an ornament, called *coral*, is formed in this way; it is the stem found in the midst of an aggregation of certain polyps, that serves to sustain and attach them to the earth (*fig.* 89). These little animals, only two or three lines in length, have at their free extremity eight tentacles, in the middle of which is the mouth; by their opposite extremity they are fixed in little cavities hollowed out in a kind of membrane or living bark, which is common to all, and into which they can entirely withdraw themselves; this common part is more or less branched, and in its centre are found successive layers of very hard, stony matter, which is the coral. This coral is found plentifully in the Mediterranean, principally on the African coast, where it forms the object of an active fishery.

Fig. 89.—CORAL.

20. Fresh-water polyps (*fig.* 90) or *Hydræ* (from the Greek, *'udor*, water) may be considered as the most simple type of this group. The body is a gelatinous tube, in which no particular organ is perceived; nevertheless they crawl and swim actively, by agitating their long tentacles, to seize small animals that come within their reach, which they devour with great avidity; they seem to be sensible to the influence of light. Some of these polyps have

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19. What is red coral? Where is it found?
20. What are hydras? Where are they found?

been turned inside out, and yet the cavity thus formed, having the skin inside, performed the functions of the natural stomach; but what is most singular and astonishing is their great tenacity of life, which enables them to live even after they are cut into pieces, and each fragment afterwards becomes an entire and perfect hydra.

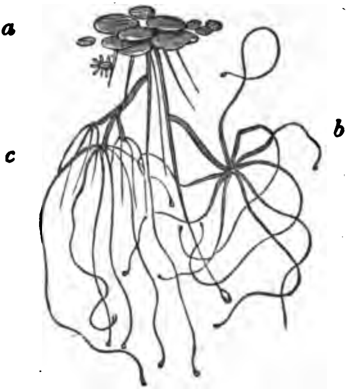

Fig. 90.—HYDRÆ.

"When left free, the hydræ are found to select positions most exposed to the influence of light, assembling at the surface of the ponds which they inhabit, or seeking that side of the glass in which they are confined, that is most strongly illuminated. That they are able to appreciate the presence of light is therefore indubitable; yet with what organs do they perceive it? we are driven to the supposition, that, in this case, the sense of touch supplies to a certain extent the want of other senses, and that the hydræ are able *to feel* the light.

"When the hydra is watching for its prey, it remains expanded (*fig.* 90, *b*), its tentacles widely spread and perfectly motionless, waiting patiently till some of the countless beings which populate the stagnant waters it frequents, are brought by accident in contact with them: no sooner does an animal touch one of the filaments, than its course is arrested, as if by magic; it appears instantly fixed to the almost invisible thread, and in spite of its utmost efforts is unable to escape; the tentacle then slowly contracts, and others are brought in contact with the struggling prey, which, thus seized, is gradually dragged towards the orifice of the mouth, that opens to receive it, and slowly forced into the interior of the stomach."—*Jones.*

21. **Sponges** live in the sea, attached to rocks: they bear some analogy to the common mass in which certain polyps are lodged, but we find none of these animals on them. Their surface is perforated by an immense number of holes which communicate with canals running through their substance in every direction, and through which currents of water are continually passing (*fig.* 91). Sponges are found in a variety of forms; some are like

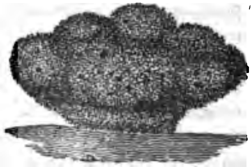

Fig. 91.—SPONGE.

Explanation of Fig. 90.—*a*, represents small patches of vegetable matter, floating on the water, beneath which hydræ are ordinarily found;—*b*, one of these polyps;—*c*, another, having two young ones attached to it.

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21. What are sponges? Where are they found?

horns, spheres, cups, fans, shrubs, &c.; some are studded with fine stony needles; others are sustained internally by flexible fibres, arranged so as to form tubes and little cells.

Common sponge, of which we make so much use, has a structure of the latter description; it constitutes large brownish masses, and is found in the Mediterranean.

GEOGRAPHICAL DISTRIBUTION OF ANIMALS.

To form a general idea of the animal kingdom, it is not enough to know the principal phenomena by which life is manifest in animate creatures, and to have studied the structure of their bodies, and the mechanism of their functions; we must also look at the manner in which animals are distributed over the face of the earth, and endeavour to appreciate the influence which the different circumstances in which they are placed may exercise over them.

When we look at the manner of distribution of animals on the globe, we are at first struck with the difference of the media they inhabit. Some, as every body knows, always live under water and quickly die when withdrawn from it; others can only exist in the air and almost immediately perish when submerged. Some in fact are destined to inhabit the waters, and others to live upon the land; and when we compare aquatic and terrestrial animals, in their physiological and anatomical relations, we find, at least in part, the causes of the differences in their mode of existence.

In studying respiration, we pointed out the constant relation between the intensity of this function and vital energy. Animals consume in a given time a quantity of oxygen, increasing in proportion to the activity of their motions and rapidity of their nutrition: now, they can obtain this oxygen only from the fluids surrounding them; in a gallon of air there are about 84 cubic inches of this vivifying principle, while in a gallon of water we ordinarily find only about five cubic inches. It is evident then that the degree of activity in the respiratory function, indispensable to the exercise of the faculties belonging to superior animals, must be of more easy attainment in air than in water, and on account of this difference alone, the creatures highest in the animal series cannot dwell in water. We comprehend, indeed, that an animal which, in order to exist, must appropriate a considerable quantity of oxygen every instant, does not find it in sufficient quantity when plunged into water, and therefore perishes of asphyxia. But at first sight, it is not so easy to explain why an aquatic animal cannot continue to live when taken from the water and placed in the air, for then we supply it with a fluid richer in oxygen than that, the vivifying action of which was sufficient for all its wants. There are, however, various circumstances which, to a certain degree, explain this phenomenon. Physics teach us that a body carefully weighed in air and in water, is lighter in the last than in the first, and that, to sustain it in equilibrium, there is then only required a weight equal to its weight in air, less that of the bulk of water it displaces. Hence it follows that animals whose tissues are too soft to sustain themselves in air, and are compressed to such an extent as to become unfit to perform their functions in the organism, can nevertheless live very well in water, where these same tissues, being not much more dense than the surrounding fluid, are required to possess only a feeble power of resistance to preserve their forms and to prevent the several parts of the body from falling together on each other. This consideration alone is sufficient to show us why gelatinous animals, such as infusoriæ or medusæ, are necessarily inhabitants of the water; for, when we observe one of these delicate creatures while still in this fluid, we perceive that all the parts, even the most slender tissues, are sustained in their proper position and float easily in the surrounding medium; but the moment they are withdrawn, their body is almost entirely effaced, offering to the eye only a confused and shapeless mass. The influence of the density of the surrounding medium upon the mechanical play of these instruments of life is also felt in animals of a more perfect structure, in which, however, respiration is still carried on by means of ramified membranous appendages, resembling diminutive shrub-branches or plumes. For example, in anne'lidans or even in fishes, the branchiæ or gills are composed of flexible filaments, which easily sustain themselves in water, and therefore permit the respirable fluid to reach and renew itself at all points of their surface; but, in air, these same membranous filaments are in a measure effaced by their own weight, falling one on another, and, in this way, exclude the oxygen from the greater part of the respiratory apparatus. It results that this function is then embarrassed, and the animal may die of asphyxia in the air, although it found in water all it required for free respiration. To convince ourselves of the importance of these variations in the physical state of organs placed in air or in water, it is only necessary to be reminded of what is seen in dissecting-rooms: an anatomist desirous of studying the structure of a very delicate part, would succeed very indifferently if he made his dissection in air; but by placing the subject of investigation in water, he much more easily succeeds in distinguishing all the parts; because these parts, sustained in a measure by this liquid, then preserve their natural relations just as if they were of a consistent and stiffer tissue. Another circumstance which influences the possibility of living in air or in water is the evaporation which always takes place from the surface of organized bodies placed in the air, but which cannot take place in water. A certain degree of dessication causes all organic tissues to lose their distinguishing physical properties, and we find that losses by evaporation always produce death in animals when they exceed certain limits. It follows that creatures whose organization is not calculated to preserve them against the injurious effects of evaporation, can only live in water and quickly perish in air. Now the animal economy is equal to this exigence only when it possesses a very complicated structure. In fact, if an active respiration be requisite, the respiratory surface must be deeply lodged in some internal cavity where the air can be renewed only in proportion as it is required for the support of life. To secure this renovation, the respiratory apparatus must be furnished with proper motive organs; to prevent the dessication or drying of any portion of the surface of the body, the diffusion of the liquids to the different parts of the body must be easily carried on, and there must be an active circulation, or the surface must be invested by a tunic or covering that is scarcely permeable. This is so true, that even in fishes, in which the circulation is very complete, although slowly carried on, and the capillary net-work not very dense, death speedily takes place in consequence of dessication of a part of the body, of the posterior portion, for example, even when this portion alone is exposed to the air, while the rest of the animal remains under water.

We may add, too, that in water, feeding may be effected with less perfect instruments of prehension than in air, where the transportation of the food required by the animal is more difficult. In all its most essential relations, life is, in a manner, more easily maintained in the midst of the waters than on the surface of the earth; in the atmosphere it demands more perfect and more complicated physiological instruments: the water is the natural element of animals lowest in the zoological series; and if the productions of the creation have succeeded each other in the same order as the transitory states through which every animal passes, during the period of its development, we may conclude that animate creatures first appeared in the midst of the waters, a conclusion in accordance with the observations of geologists and the text of the Scriptures.

In this manner the physiologist can account for the division of animals between the two geological elements of the globe, water and earth; but these fundamental differences are not the only ones observed in the geographical distribution of animate creatures. If a naturalist familiar with the fauna* of his own country, visit distant regions, he sees, as he advances, that the land becomes inhabited by animals new to his eyes; then these species disappear, in their turn to give place to species equally unknown.

If, after leaving France, he land in the South of Africa, he will find there only a small number of animals similar to those he saw in Europe, and he will remark especially the Elephant, with big ears; the Hippopo'tamus; the Rhinoceros, with two horns; the Giraffe; innumerable herds of Antelopes; the Zebra; the Cape Buffalo, the widened base of whose horns cover the front; the black-maned Lion; the Chimpanzee, which of all animals most resembles man; the Cynocephalus, or dog-faced Monkey; Vultures of particular species; a multitude of birds of brilliant plumage, strangers to Europe; insects, also different from those of the north; for example, the fatal Termite, which lives in numerous societies, and builds, in common, its habitation of earth, which is very curious in its arrangement and of considerable height.

If our zoologist leave the Cape of Good Hope, and penetrate into the interior of the great island of Madagascar, he will there find a different fauna. He will see none of the large quadrupeds he met in Africa; in place of the family of monkeys, he will find other mammals equally well formed for climbing trees, but more resembling the carna'ria, designated by naturalists under the name of *makis*; he will meet the *ai-ai* or sloth, a most singular animal, which appears to be a sort of object of veneration among the inhabitants, and partakes of the nature of both monkey and squirrel; Tenrecs (a kind of hedge-hog), small insecti'vorous mammals, which have spiny backs like hedge-hogs, but do not roll themselves in a ball; the Came'leon, with forked nose, and many curious reptiles not found elsewhere, as well as insects not less characteristic of that region.

Still pursuing his route and arriving in India, our traveller sees an elephant different from that of Africa; oxen, bears, rhinoceros, antelopes, stags, different from those of Africa and Europe; the ourang-outang, and a multitude of other monkeys peculiar to those countries; the royal tiger, the argus, the peacock, pheasants, and an almost innumerable host of birds, reptiles, and insects, unknown elsewhere.

If he now visit New Holland, all will be there again new to him, and the aspect of this fauna will appear to him still more strange than the various zoological populations he has passed in review. He will no longer meet with species analogous to our oxen, horses, bears, and large carna'ria; large-sized quadrupeds are almost entirely wanting; he will find kangaroos, flying-phalangers, and the ornithoryn'chus.

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* *Fau'na*, from the Latin, *faunus*, the name of a rural deity among the Romans. The animals of all kinds peculiar to a country constitute its *Fauna*.

Finally, if our traveller, to get back to his own country, traverses the vast continent of America, he will discover a fauna analogous to that of the old world, but composed almost entirely of different species; he will there see monkeys with a prehensile tail, large carna'ria similar to our lions and tigers, bisons, lamas, armadillos; birds, reptiles, and insects, equally remarkable, and equally new to him.

Differences not less great in the species of animals peculiar to different regions of the globe, are observed, when, instead of confining our observations to the inhabitants of the land, we examine the myriads of animated creatures that dwell in the midst of the waters. Passing from the coasts of Europe to the Indian Ocean, and from the latter into the American seas, we meet with fishes, mollusks, crusta'ceans, and zoophytes, peculiar to each of these regions. This limitation or colonization of species, whether aquatic or terrestrial, is so marked, that a slightly experienced naturalist cannot mistake, even at first sight, the original localities of zoological collections that may have been gathered in one or the other of the great geographical divisions of the globe, and submitted to his examination. The fauna of each of these divisions is peculiar to it, and may be easily characterized by the presence of certain more or less remarkable species.

Naturalists have formed many theories to account for this mode of distribution of animals over the surface of the globe; but, in the present state of science, it is impossible to give a satisfactory explanation, without admitting that, in the beginning, the different species had their origin in the different regions where they are found, and that by degrees they afterwards spread afar and occupied a more or less considerable portion of the surface of the earth. In short, the presence of a particular animal within narrow limits on the earth, necessarily supposes, when this animal is found nowhere else, that it had its origin on this spot, or that it imigrated there from a more or less remote region, and that subsequently it was entirely destroyed where its race commenced, that is, exactly at the place where, according to every probability, all circumstances most favourable to its existence were found in combination. There is nothing strongly in favour of this last hypothesis, and it is repugnant to common sense to believe that, in the beginning, the same country saw the birth of the horse, the giraffe, bison, and kangaroo, for instance, but that these animals left it afterwards, without leaving any trace of their passage, to colonize, one on the steppes of central Asia, another in the interior of Africa, a third in the New World, and another again in the great islands of Australia. It is much more natural to suppose that every species was placed, from the beginning, by the Author of all things, in the region where it was destined permanently to live, and that by extending from a certain number of these distinct centres of creation, different animals have spread throughout those portions of the globe now forming the domain of each kind. In the present condition of the earth, it is impossible to recognise all those zoological centres: for we can conceive the possibility of exchanges so multiplied between two regions, the faunæ of which were primitively distinct, that they present species common to both, and nothing now points out to the eyes of the naturalist their original separation; but when a country is inhabited by a considerable number of species which are not seen elsewhere, even where local circumstances are most similar, we are warranted in the supposition that this region was the theatre of a peculiar zoological creation, and we must regard it as a distinct region.

What the naturalist should ask, is, not how different portions of the earth have come now to be inhabited by different species, but how animals could be so far extended over the surface of the globe, and how nature placed variable limits to this dissemination according to species. The latter question especially presents itself to the mind when we consider the unequal extent now occupied by this or that group of animated creatures: for example, the ourang-outang is confined to the island of Borneo and the neighbouring lands; the musk-ox is colonized in the most northern part of America, and the lama in the elevated regions of Peru and Chile, while the wild-duck is seen everywhere, from Lapland to the cape of Good Hope, and from the United States to China and Japan.

The circumstances which favour the dissemination of species are of two kinds: the one pertains to the animal itself, and the other is foreign to it. Among the first is the development of the locomotive power, all things being equal in other respects; the species which live attached to the earth, or which possess only imperfect instruments of locomotion, occupy a very limited extent of the earth's surface, compared to those species whose moving powers are rapid and energetic: among terrestrial animals, birds present us with most examples of cosmopolite species, and, among aquatic animals, the ceta'ceans, and fishes. Reptiles, on the contrary, are restricted to narrow limits, and the same is true of most mollusks and crusta'ceans. The instinct possessed by certain animals to change their climate periodically, also contributes to the dissemination of species; and this instinct exists in a great number of these creatures.

Among the circumstances foreign to the animal, and in a measure accidental, we place first the influence of man; and to illustrate this point, a few examples will suffice. The horse is originally from the steppes of Central Asia, and, at the time of the discovery of America, no animal of this species existed in the New World; the Spaniards carried it with them there not more than three centuries back, and now, not only do the inhabitants of this vast continent, from Hudson's Bay to Terra del Fuego, possess horses in abundance, but these animals have become wild, and are found in almost countless herds. The same is true of the domestic ox: carried from the Old to the New World, they have multiplied there to such an extent that in some parts of South America they are actively hunted for their hides only, for the manufacture of leather. The dog has been everywhere the companion of man, and we could instance a great many animals that have become cosmopolite by following us; the rat, which appears to be originally from America, overran Europe in the middle ages, and is now met with even on the islands of Ocea'nica.

In some cases, animals have been able to break through natural barriers, seemingly insurmountable, and spread themselves over a more or less considerable portion of the surface of the globe, by the assistance of circumstances whose importance at first sight seems very trifling, such as the movement of a fragment of ice or wood, often carried to considerable distances by currents: nothing is more common than to meet at sea, hundreds of miles from land, fucus floating on the surface of the water and serving as a resting-place for small crusta'ceans incapable of transporting themselves, by swimming, far from the shores where they were born. The great maritime current, the gulf-stream, commencing in the gulf of Mexico, coasts North America to Newfoundland, then directs its course to Iceland, Ireland, and returns towards the Azores, often bearing to the coasts of Europe, trunks of trees which were conveyed by the waters of the Mississippi, from the most interior parts of the New World, to the sea; it frequently happens that these masses of wood are perforated by the larvæ of insects, and they may afford attachment to the eggs of mollusks, and of fishes, &c. Finally, even birds contribute to the dispersion of living creatures over the surface of the globe, and that too in a most singular manner: frequently they do not digest the eggs they swallow, but, evacuating them at places far from where they were picked up, carry to great distances the germs of races unknown till then in the countries where they were deposited.

Notwithstanding all these means of transportation and other circumstances favouring the dissemination of species, there are very few animals that are really cosmopolites, the most of these creatures being colonized within limited regions. That such should be the case, we can comprehend, if we study the circumstances which may oppose their progress. But this study is far from furnishing us a satisfactory explanation of all cases of limited circumscription of a species, and it is often impossible to divine why certain animals remain restricted to a locality, when nothing seems to oppose their propagation in neighbouring situations.

Whatever may be the reason, the obstacles to the geographical distribution of species are sometimes mechanical, and at others, physiological; among the first are seas and chains of lofty mountains. To terrestrial animals seas of much extent are in general an impassable barrier, and we perceive, all things being equal, the mixture of two distinct faunæ is always most intimate in proportion as the regions to which they belong are, geographically, most approximated, or in communication with each other, by intermediate lands. The Atlantic Ocean prevents species peculiar to tropical America, from extending to Africa, Europe, or Asia; and the fauna of the New World is entirely distinct from that of the old continent, except in the highest latitudes, towards the north pole. But there the land of the two continents is approximated, America being separated from Asia only by Behring's Straits, and is connected to Europe by Greenland and Iceland: on this account zöological exchanges can be more easily effected, and we find there species common to both worlds; for example, the white bear, the reindeer, the castor, the ermine, the bald eagle, &c. Chains of lofty mountains also constitute natural barriers, which arrest the dispersion of species, and prevent the admixture of faunæ, proper to neighbouring zoological regions. For instance, the opposite declivities of the Cordillera of the Andes are inhabited by species which are for the most part different; the insects of the Brazilian side, for example, are almost all distinct from those found in Peru and New Granada.

The dispersion of marine animals living near coasts is prevented in the same manner by the geographical configuration of the earth; but here it is sometimes a continuation of a long chain of land, and sometimes a vast extent of open sea, which opposes the dissemination of species. Thus most animals of the Mediterranean are also found in the European portion of the Atlantic, but they do not extend to the seas of India, from which the Mediterranean is separated by the isthmus of Suez, nor can they traverse the ocean to gain the shores of the New World.

The physiological circumstances which tend to limit the different faunæ are more numerous; and without doubt, the first in consideration is the unequal temperature of different regions of the earth. There are species which can bear an intense cold and tropical heat equally well; man and the dog, for example; but there are others which, in this respect, are less favoured by nature, and which do not flourish, or even cannot exist, except under the influence of a determined temperature. For instance, monkeys, which thrive in tropical regions, almost always die of phthisis, when exposed to the cold and humidity of our climate; while the reindeer, formed to support the rigours of the long and severe winter of Lapland, suffers from the warmth of St. Petersburgh, and generally succumbs to the influence of a temperate climate. Hence it is that, in a great number of cases, the difference of climate is alone sufficient to arrest species in their march from high latitudes towards the equator, or from the equatorial regions towards the poles. The influence of temperature, on the animal economy, also explains why certain species remain within a chain of mountains, without being able to extend beyond it to analogous localities. We know, in fact, that temperature decreases in proportion to the elevation of the land, and consequently, animals that live at considerable heights cannot descend on to the low plains, to reach other mountains, without traversing countries in which the temperature is much higher than that of their ordinary dwelling. The lama, for example, abounds on the pastures of Peru and Chile, situated at a height of from twelve to fifteen thousand feet above the level of the sea, extending southwards to the extremity of Patagonia, but is not seen either in Brazil or Mexico, because it cannot reach those countries without descending to regions too warm for its constitution.

The nature of the vegetation, and of the previously existing fauna, in a region of the globe, also exerts an influence on its invasion by exotic species. Thus, the dispersion of the silkworm is limited by the disappearance of the mulberry, beyond a certain degree of latitude; the cochineal cannot spread beyond the region in which the cactus grows; and the large carna'ria, except those that live on fishes, cannot exist in the polar regions, where vegetable productions are too poor to nourish any considerable number of herbi'vorous quadrupeds.

It would be easy to multiply examples of these necessary relations between the existence of an animal species, in a particular place, and the existence of certain climatic, phytological, or zoological conditions; but our limits do not permit these details, and the considerations we have already presented, appear to be sufficient to give an idea of the manner in which nature has effected the dissemination of animal species, on different parts of the earth's surface; and, to attain the end we proposed to ourselves in commencing the subject, it only remains for us to glance at the results brought about by the different circumstances we have just mentioned, that is, the present state of the geographical distribution of animated creatures.

When we compare with each other the different regions of the globe, in respect to their zoological population, we are at first struck by the extreme inequality remarked in the number of species. In one country we find a great diversity in the form and structure of the animals composing its fauna, while in another place, there is great uniformity in this respect; and it is easy to perceive a certain relation existing between the different degrees of zoological richness, and the more or less considerable elevation of temperature. In fact, the number of species, both marine and terrestrial, augments, in general, as we descend from the poles towards the equator. The most remote lands of the polar regions offer little to the observation of the traveller but some insects, and in the glacial seas the fishes and mollusks are but little varied; in temperate climates the fauna becomes more numerous in species; but it is in tropical regions that nature has displayed the greatest prodigality in this respect, and the zoologist cannot behold without astonishment the endless diversity of animals that he there finds assembled.

It is also remarked that there is a singular coincidence between the elevation of temperature in different zoological regions, and the degree of organic perfection of the animals which inhabit them. It is in the warmest climates that those animals live that most nearly resemble man, and also those in the great zoological divisions which possess the most complicated organization, and the most developed faculties, while in the polar regions we meet with creatures occupying a low rank in the zoological series. Monkeys, for example, are confined to the warm parts of the two continents; the same is true of parrots among birds, of crocodiles and tortoises among reptiles, and of land-crabs among crusta'ceans, all of them the most perfect animals of their respective classes.

It is also in warm countries that we find animals the most remarkable for the beauty of their colours, their size, and the strangeness of their forms.

Indeed there seems to exist a certain relation between the climate and the tendency of nature to produce this or that animal form. We observe a very great resemblance between most animals inhabiting the extreme northern and southern regions; the faunæ of the temperate regions of Europe, Asia, and North America, are very analogous in their general aspect, and in the tropical regions of the two worlds similar forms predominate. It is not identical species that we meet in distinct and nearly isothermal regions, but species more or less approximating to each other, which seem to be the representatives of one and the same type. For example, the monkeys of India and of Central Africa are represented in tropical America by other monkeys easily distinguishable from the first; the lion, tiger, and panther, of the old continent, correspond to the cougar, jaguar, and ounce, of the New World. The mountains of Europe, Asia, and North America, nourish bears of distinct species, but differing very little from each other. Seals abound especially in the neighbourhood of the polar circles; and if we seek the proofs of this tendency, not among the highest classes of the animal kingdom, but among the inferior creatures, they will be found not less evident: cray-fishes, for example, appear to be confined to the temperate regions of the globe, and are found throughout Europe, in a species common to European streams; in the South of Russia, there is a different species; in North America, there are two species, distinct from the preceding; in Chile, there is a fourth species; in the south of New Holland, a fifth; in Madagascar, a sixth; and at the Cape of Good Hope, a seventh.

A comparison of the faunæ peculiar to the different zoological regions of the globe leads to other results for which it is more difficult to account; when we examine successively the assemblage of species inhabiting Asia, Africa, and America, we remark that the fauna of the New World is characterized by inferiority, a fact which did not escape the celebrated Buffon. In a word, there are no mammals existing now in the New World as large as those of the old; it is true, we find, in America, a considerable number of monkeys, but among them there is none equal to the ourang-outang, or chimpanzee; the roden'tia and edenta'ta abound most, which, of all ordinary mammals, are the least intelligent. Finally, in America, we find opossums, animals belonging to an inferior type of ordinary mammals, which have no representative, neither in Europe, nor Asia, nor Africa. If we pass from the New World to the still newer region of Australia, we shall there see a fauna whose inferiority is still more decided, for there the class of mammals is scarcely represented by the Marsu'pials and Monotre'mata.

As to the limitation of the different zoological regions into which the globe is divided, and the composition of the faunæ proper to each, we cannot treat without exceeding our limits; but we regret this less, because, in the present state of science, these questions are far from being settled.

Here we terminate our zoological studies: for the object we proposed to ourselves was not a particular description of each animal, nor an enumeration of those characters which would enable us to recognise or group them methodically; we were merely desirous of giving some notion of the nature and properties of these creatures, to sketch rapidly the prominent traits of their history, and furnish our young readers the general knowledge most useful to all, and indispensable to those who wish to study more profoundly this branch of the sciences of observation

GLOSSARY.

ENTOMOLOGY.

Abdo'men.—From the Latin, *abdere*, to conceal. The belly; that part of the trunk which contains the stomach, liver, intestines, &c.

Abdo'minal. — Relating to the abdomen.

Abran'chia (*a-bran'-kea*). — In the plural, abran'chiæ. Abran'chians. From the Greek, *a*, without, and *bragchia*, gills. An order of annelidans, so called, because the species composing it have no external organs of respiration.

Abran'chiate.—Relating to, or of the nature of abranchia.

Acale'pha.—From the Greek, *akalephe*, a nettle. Class of radiate animals, so called, on account of the singular property possessed by most of the species, of irritating and inflaming the skin, when touched.

Acale'phæ.—Plural of acale'pha.

Acale'phans.—Animals of the class Acale'pha.

Aca'rides.—A tribe of arachnidans.

A'carus.—From the Greek, *akari*, a mite. A genus of arachnidans.

A'cari.—Plural of Acurus.

Acou'stic.—From the Greek, *akouô*, I hear. Relating to sound, or hearing.

A'crid.—From the Latin, *acer*, sharp, sour. Burning, irritating.

Acry'dium.—From the Greek, *akris*, a locust. Name of a genus of insects.

Acti'nia.—From the Greek, *aktin*, a ray. A genus of polypi, with very numerous tentacles, which extend, like rays, from the circumference of the mouth (*fig*. 87).

Acu'leates. — From the Latin, *aculeus*, a prickle. A tribe of hymenopterous insects, in which the females and neuters are provided with a sting, generally concealed within the last segment of the abdomen.

Ag'gregated.—From the Latin, *aggrego*, I gather. Collected together.

Aggrega'tion.—A collection: a mass composed of many.

Agglom'erated. — From the Latin, *ad*, to, and *glomero*, I heap up. Gathered into a ball or heap.

Alimen'tary. — Affording nourishment.

Amphi'poda. Amphi'pods. } From the Greek, *amphis*, on both sides, and *pous*, foot. An order of crusta'ceans.

Amphitri'te. — A genus of annelidans.

Amputa'tion.—From the Latin, *amputare*, to cut off. The act of cutting off or removing a limb or projecting part.

Ana'tifa. — Plural, *anatifæ*. From the Latin, *anas*, in the genitive case, *anatis*, a duck, and *fero*, I bear. A genus of cirrhopods. It was for a long time believed that certain ducks were derived from the metamorphosis of these animals; and for this reason they were called *ana'tifa*.

Anel'lida. Anel'lides. } From the Latin, *anellus*, a little ring. It is, also, written *annelida*, and *annelides*. A class of articulate animals.

Anel'lidæ. Anne'lidæ. } Plural of anellida and annelida

Anne'lidan.—An animal of the class anel'lida.

Anima'lia.—Latin. Animals.

Anima'lity.—From the French, *animalité*. The peculiar vital property or character which belongs to and distinguishes animals.

Anima'lcule.—A diminutive animal.

Annular.—In form of a ring.

An'nulus. — In the plural, annuli. Latin. A ring.

Ano'bium. — From the Greek *anô*, above, upwards, and *bainô*, I ascend. Generic name of certain beetles.

Anomou'ra. — From the Greek, *anomos*, irregular, and *oura*, tail. A division of crusta'ceans.

Anten'na.—Latin. A yard-arm. A tubular, jointed, filiform organ, placed on the head of insects, and some other animals. A feeler.

Anten'næ.—Plural of antenna.

Antepec'tus.—From the Latin, *ante*, before, and *pectus*, the breast. The under surface of the first ring of the thorax in insects.

Antester'num. — From the Latin, *ante*, before, and *sternum*, the breast-bone. The fore part of the middle line of the breast-plate; the centre of the antepectus.

Anthopho'ra.—In the plural, anthophoræ. From the Greek, *anthos*, a flower, and *pherô*, I bear. Name of a genus of hymenopterous insects. Applied also to insects whose habits are analogous to bees.

A'nus.—The outlet or inferior opening of the intestines.

Aor'ta. — The main artery of the body.

Aor'tic. — Belonging to, or of the nature of the aorta.

A'phis. — From the Greek, *aphis*, a plant-louse, a vine-fretter.

A'phides. — Plural of aphis. Plant-lice.

Aphro'dita. — A genus of annelidans.

A'pis.—Latin. A bee.

Appara'tus. — Latin. Formed from *ad*, for, and *parare*, to prepare. A collection of organs or instruments for any operation whatever.

A'podous.—From the Greek, *a*, without, and *pous*, foot. Without feet.

Ap'tera.—From the Greek, *a*, without, and *pteron*, wing. A division of insects, characterized by being without wings.

Ap'terous.—Without wings; wingless.

Aqua'tic. — Belonging or relating to the water.

Arach'nida (*arak'-ne-da*).—From the Greek, *arachne*, a spider. A class of articulated animals.

Arach'nidæ.—Plural of arachnida.

Arach'nidans. } Animals of the class
Arach'nides. } Arachnida.

Arane'ida (Plural, arane'idæ). — From the Latin, *aranea*, a spider. A tribe of pulmonary arach'nidans.

Arenico'la (Plural, arenicolæ). — From the Latin, *arena*, sand, and *colo*, I inhabit. A genus of annelidans.

Ar'teries.—Blood-vessels, which convey blood *from* the heart, to all parts of the body: blood is carried back to the heart, from all parts of the body, by the veins.

Arti'culata.—Latin. Articulated.

Arti'culate. } Having articula-
Arti'culated. } tions; jointed.

Articula'tion.—A joint.

Asca'rides.—A genus of worms.

Asphyx'ia.—From the Greek, *a*, without, and *sphuxis*, pulsation. State of suspended animation, or seeming death.

Assimila'tion.—A part of the function of digestion, by which the food, previously prepared by the digestive organs, is converted into organic matter, similar to that composing the various animal tissues.

Asta'cus.—Latin. A lobster.

Ateu'chus (*a-tue-kus*).—A genus of insects.

A'tropos.—Greek name of one of the Fates. A genus of insects.

Aura'tus.—Latin. Golden; gilded.

Autumna'lis. — Latin. Autumnal. Belonging to the autumn.

Bala'ni.—Plural of balanus.

Bala'nus.—Latin. A barnacle.

Bifid. — Split into two points or parts.

Bilia'ry.—Belonging or relating to bile.

Bomby'ces.—Plural of bombyx.

Bo'mbyx. — From the Greek, *bom-*

bux, a silk-worm. A genus of insects.

Bra'chyu'ra (*brak-e-u-ra*). — From the Greek, *brachus*, short, and *oura*, tail. A tribe of crusta'ceans.

Bran'chia (*bran'-ke-a*). — Latin. A gill.

Bran'chiæ. — Plural of branchia. Gills.

Bran'chial.—Belonging or relating to gills.

Buc'cal. — From the Latin, *bucca*, cheek. Belonging or relating to the cheeks.

Cæmenta'ria. — Latin. Belonging or relating to mortar.

Calca'reous.—Of the nature of lime.

Can'cer.—Latin. A crab.

Can'tharis.—Latin. A kind of fly.

Cantha'rides.—Plural of cantharis.

Capil'lary.—Hair-like.

Ca'rapace. — The shell of crustaceans.

Ca'rabi.—Plural of Carabus.

Ca'rabus.—A genus of insects.

Carna'ria. — Name of an order of mammals.

Carni'vora. — Latin. Carni'vorous. Name of a class of insects.

Carni'vorous.—From the Latin, *caro*, *carnis*, flesh, and *voro*, I eat. Flesh-eating.

Car'tilage.—Gristle.

Cartila'ginous. — Of the nature of cartilage.

Cau'dal. — From the Latin, *cauda*, tail. Relating to a tail.

Caus'tic. — From the Greek, *kaiô*, I burn. Applied to substances which have the power of burning or disorganizing animal tissue.

Cavita'ria. — From the Latin, *cavitas*, a hollow, a cavity. An order of Entozoa, in which the intestinal canal is contained in a distinct abdominal cavity.

Ce'ntiped.—From the Latin, *centum*, a hundred, and *pes*, foot. A hundred legs; a genus of myriapods.

Cepha'lic.—From the Greek, *kephale*, head. Belonging or relating to the head.

Ce'phalo-thorax.—From the Greek, *kephale*, head, and *thorax*, chest. Term applied to that part of the body of arachnidans, composed of the head and thorax.

Ceta'ceans.—An order of mammals, which includes the whale.

Cer'vus.—Latin. A stag.

Chela.—Plural, chelæ. Latin. From the Greek, *chele*, pincers. A crab's claw.

Cheli'cera.—Plural, cheliceræ. From the Greek, *chele*, pincers, and *keras*, horn. A term applied to appendages on the head of arachnidans.

Chry'salid. Chry'salis. — From the Greek, *chrusos*, gold. The second stage of the metamorphosis of insects.

Chyle (*kile*).—A nutritious fluid, a result of the digestion of food, fitted for assimilation.

Chyli'ferous. — From the Greek, *chulos*, chyle, and *fero*, I bear. Chyle-bearing.

Cica'da.—Latin. A grasshopper.

Cicin'dela.—From the Latin, *cicen'dela*, a glow-worm. Name of a genus of beetles.

Cil'ia.—Plural, ciliæ. Latin. Eyelash.

Ci'mex.—Latin. A bug.

Cir'riped. Cir'rhopod. — A description of articulated animals.

Cir'rhopoda. Cir'ripeda. — From the Latin, *cirrus*, a tendril, and *pes*, foot. A class of articulated animals.

Cir'ri. — Latin, plural of cirrus. Tendrils.

Clavicor'nes.—From the Latin, *clavus*, a club, and *cornu*, horn. Name of a family of insects.

Clo'aca.—A sewer.

Cly'peus.—Latin. A buckler. Name of that part of the head of insects to which the labrum is attached.

Coccinel'la.—From the Latin, *coccinus*, crimson. Name of a genus of insects.

Cocoo'n. — The silken case which the larvæ of certain insects spin, to cover them during a period of their metamorphosis.

Coc'cus.—Latin. Scarlet cloth. Generic name of the cochineal insect.

COLEOP'TERA.—From the Greek, *koleos*, a sheath, and *pteron*, wing. Name of an order of insects.

COLEOP'TERÆ.—Plural of Coleop'tera.

COLEOP'TEROUS.—Belonging or relating to Coleop'tera.

CO'PRIS.—From the Greek, *kopros*, dung. A genus of insects.

CO'RAL.—From the Greek, *koreô*, I ornament, and *als*, the sea. The hard calca'reous support, formed by certain polypi.

COR'NEA.—From the Latin, *cornu*, horn. The transparent part of the eye-ball.

COR'NEÆ.—Plural of cornea.

CORIA'CEOUS.—Leathery.

CORSE'LET.—The second segment or ring of the body of insects.

COSMO'POLITE.—From the Greek, *kosmos*, world, and *polis*, city. A citizen of the world.

COX'A.—Latin. Hip.

CREPUS'CULAR.—From the Latin, *crepuscula*, twilight. Relating to twilight.

CRUSTA'CEA.—From the Latin, *crusta*, a crust. A class of articulated animals.

CRUSTA'CEÆ.—Plural of Crusta'cea.

CRUSTA'CEAN.—Of the class of Crusta'cea.

CRUSTA'CEOUS.—Of the nature, or belonging to Crustaceans.

CU'TICLE.—The scarf-skin.

CU'TIS.—Latin. The skin: the true skin.

CU'LEX.—Latin. A gnat.

CY'NIPS.—A genus of insects.

DE'CAPOD.—Of the family of Decapoda.

DECAPO'DA.—From the Greek, *deca*, ten, and *pous*, foot. A family of Crusta'ceans.

DEGLUTI'TION.—The act of swallowing.

DEMI-ELY'TRA.—From the French, *de'mi*, half, and *e'lytrum*. Half-wing cases.

DENTA'LIUM.—From the Latin, *dens*, a tooth. A genus of cirrhopoda.

DEN'TATE.—Toothed.

DENTICULA'TION.—A tooth-like projection.

DERMES'TES.—From the Greek, *derma*, skin, and *esthiô*, I eat. A genus of insects.

DIA'PHANOUS.—From the Greek, *dia*, through, and *phainô*, I appear. Transparent; that which may be seen through.

DIP'TERA.—From the Greek, *dis*, two, and *pteron*, wing. An order of insects.

DIP'TERÆ.—Plural of Dip'tera.

DIP'TEROUS.—Relating to Dip'tera.

DIUR'NAL.—From the Latin, *dies* day. Daily.

DOMES'TICA. } Latin. Domestic; relating to home.
DOMES'TICUS. }

DOR'SAL.—From the Latin, *dorsum*, the back. Relating to the back.

DOR'SIBRANCH. } Having dorsal branchiæ or gills. Relating to Dorsibra'nchiata.
DOR'SIBRAN'CHIATE. }

DORSIBRAN'CHIATA.—From the Latin, *dorsum*, back, and *branchiæ*, gills. An order of annelidans.

DYTIS'CUS.—From the Greek, *dutikos*, diving, expert in diving. Name of a genus of aquatic insects.

ECHI'NODERM.—Belonging or relating to Echinodermata.

ECHINODER'MATA.—From the Greek, *echinus*, a hedge-hog, and *derma*, skin. A class of radiate animals.

ELA'BORATE. } From the Latin, *labora're*, to work.—
ELABORA'TION. }
These words are employed to signify the separation and appropriation of nutritive matter, by the action of living organs, upon substances capable of assimilation. The *elaboration* of food in the stomach produces *chyme*.

E'LATER.—From the Greek, *elater*, a leaper. A genus of insects.

E'LYTRA.—Plural of Elytrum.

E'LYTRUM.—From the Greek, *elutron*, a sheath. A wing-cover. The first pair of wings, when hard and horny, as in beetles.

ENTOMO'LOGY.—From the Greek, *entoma*, insects, and *logos*, discourse. The science of insects.

EN'TOMO'STRACANS.—From the Greek, *entomos*, incised, and *ostrakon*, a shell. A division of the class of Crusta'cea.

Entozo'a.—From the Greek, *entos*, in, and *zôon*, an animal. Name of a class of lowly organized creatures, which live in the internal organs of other animals.

Ephe'mera.—From the Greek, *ephemeros*, daily. A genus of insects. Day-flies, so called, because their last stage of existence is generally limited to twenty-four hours.

Ephe'meræ.—Plural of Ephemera.

Epider'mis.—From the Greek, *epi*, upon, and *derma*, skin. The cuticle or scarf-skin.

Euni'ce.—Greek. A genus of annelidans.

Excre'tion.
Excre'tory. } From the Latin, *excer'nere*, to separate from. The throwing off those matters which are supposed to be useless, or injurious to organic life, as the perspiration in animals. An *excretion* is a secretion thrown off. An *excretory duct*, is any duct conveying off an excretion from an organ.

Exo'tic.—From the Greek, *exôtikos*, foreign. Any thing introduced into one country, from some other country, is so termed.

Extre'mities.—Legs, arms, wings, are so termed.

Fa'cet.—A little face, or surface.

Farina'ceous.—From the Latin, *farina*, flour. Of the nature of flour.

Fau'na.—From the Latin, *faunus*, the name of a rural deity among the Romans. All animals of all kinds peculiar to a country constitute the *fauna* of that country.

Fau'næ.—Plural of Fauna.

Fe'mur.—Latin. The thigh.

Filia'ria.—From the Latin, *filum*, a thread. A family of thread-like entozoa.

Filia'riæ.—Plural of Filia'ria.

Fi'liform.—Thread-like.

Fissipen'na.—From the Latin, *findo*, I split, and *penna*, wing. A genus of insects, remarkable for the wings being as it were split into separate parts.

Fissipen'næ.—Plural of Fissipenna.

Fis'sured.—Split, separated.

Flex'uous.—From the Latin, *flecto*, I bend. Bending.

Floc'culi.—Plural of *flocculus*, a little lock of wool.

Fluviati'lis.—Fluviatile; belonging or relating to a river.

For'ceps.—Latin. Pincers.

For'ficula.—From the Latin, *forfex*, a pair of scissors. A genus of insects.

For'mica.—Latin. An ant.

Fu'cus.—Latin. Sea-weed.

Ful'vous.—Tawny.

Func'tion.—From the Latin, *fungor*, I act. The action of an organ or set of organs.

Fu'siform.—From the Latin, *fusus*, a spindle, and *forma*, shape. Spindle-shaped.

Gale'a.—Latin. A helmet. In Orthoptera, the extremity of the lobe of the palpus, is so called.

Gan'glia.—Plural of ganglion.

Gan'glion.—From the Greek, *gagglion*, a knot. A knot or enlargement along the course of a nerve.

Gas'teropod.—From the Greek, *gaster*, belly, and *pous*, foot. A kind of mollusk.

Gecar'cinus.—From the Greek, *ge*, the earth, and *karkinos*, a crab. A genus of crusta'ceans. Land-crab.

Gela'tinous.—Of the nature of jelly or gelatine: jelly-like.

Geo'corisæ.—From the Greek, *ge*, earth, and *koris*, bug. A division of insects.

Geolo'gical.—Relating to Geology.

Geo'logist.—One skilled in Geology.

Geo'logy.—From the Greek, *ge*, earth, and *logos*, discourse. The science of the earth.

Ger'minate.—From the Latin, *germen*, a bud. To grow after the manner of a plant.

Glu'tinous.—Sticky, adhesive, gluey. Of the nature of glue.

Gra'nular.—Grain-like; composed of grains.

Grillo-tal'pa.—Compounded of *grillus*, a cricket, and *talpa*, a mole. Mole-cricket.

GRY'LLUS, also Grillus. — Latin. A cricket.

GY'RINUS.—From the Greek, *guros*, a circle. A genus of coleopterous insects.

HALTE'RES.—From the Greek, *'alteres*, lumps of lead held in the hands to aid persons taking the exercise of leaping, *like the balancing-poles of rope-dancers.* Poisers.

HEMIP'TERA.—From the Greek, *'emisus*, half, and *pteron*, wing. Name of an order of insects.

HEMIP'TERÆ.—Plural of Hæmip'tera.

HERBI'VOROUS. — From the Latin, *herba*, plant, and *voro*, I eat. Plant-eating.

HETEROME'RAN. — From the Greek, *'eteros*, various, and *meros*, joint, leg. A section of coleop'terous insects.

HETEROP'TERA. — From the Greek, *'eteros*, various, and *pteron*, wing. A section of the order Hemip'tera.

HETEROP'TERÆ.—Plural of Heterop'tera.

HEXA'GONAL.—From the Greek, *'ex*, six, and *gônia*, angle. Having six sides or angles.

HEX'APOD.—From the Greek, *'ex*, six, and *pous*, foot. Having six feet. Applied to true insects.

HIEROGLY'PHIC. — From the Greek, *ieros*, sacred, and *gluphô*, I engrave. Sculpture-writing. The name is more peculiarly applied to a species of writing, in use among the ancient Egyptians.

HOMOP'TERA.—From the Greek, *'omos*, same, and *pteron*, wing. An order of insects.

HOMOP'TERÆ. — Plural of Homop'tera.

HOMOP'TERAN.—Of the order Homop'tera.

HYDA'TIDS.—From the Greek, *'udatis*, a bladder. Name of certain entozoa.

HY'DRA. — A minute fresh water polyp.

HY'DROCO'RISÆ. — From the Greek, *'udôr*, water, and *koris*, a bug. A tribe of insects, including the water-bug.

HYMENOP'TERA. — From the Greek, *'umen*, a membrane, and *pteron*, wing. An order of insects.

HYMENOP'TERÆ. — Plural of Hymenoptera.

IMA'GO. — Latin. Image. Name given to insects after they have completed their metamorphosis.

IMBIBI'TION.—From the Latin, *in*, in, and *bibo*, I drink. The act of absorbing or soaking in.

INFUSO'RIA. — From the Latin, *infundo*, I pour in. A class of microscopic animalcules, which are for the most part developed in infusions of decayed animal and vegetable substances.

INSEC'TA.—Latin. Insects.

IN'SECT.—From the Latin, *in*, into, and *seco*, I cut. Applied to a class of animals, whose bodies are, as it were, cut into three parts; namely, head, thorax, and abdomen.

INSECTI'VOROUS. — From the Latin, *insecta*, insects, and *voro*, I eat. Insect-eating.

INSERT'ED.—From the Latin, *insere're*, to engraft. Attached; set in.

INTE'GUMENT.—Covering.

INVE'RTEBRATE.—From the Latin, *in*, without, and *vertebra*, a joint of the spine or back-bone. Without spine or back-bone.

IR'RITANS.—Latin. Irritating.

ISO'POD.—Of the order Iso'poda.

ISO'PODA. — From the Greek, *isos*, equal, and *pous*, foot. An order of crusta'ceans.

ISOTHER'MAL.—From the Greek, *isos*, equal, and *therme*, heat. Of the same heat or temperature.

LA'BIUM.—Latin. A lip. The lower lip of insects.

LA'BRUM.—Latin. A lip. The upper lip of insects.

LAMEL'LA. Latin. A thin plate or piece.

LAMEL'LÆ.—Plural of lamella.

LAMEL'LICORNES. — From the Latin, *lamel'la*, a plate, and *cornu*, a horn. A section of coleopterous insects.

LA'MINA.—Latin. A thin plate.

LA'MINÆ. — Plural of lamina. A tribe of beetles.

LAM'PYRA. — From the Greek, *lam-*

puris, a glow-worm. A genus of insects.

Lar′va.—Latin. A mask. The first state of an insect after leaving the egg.

Lectula′rius.—Latin. Belonging or relating to a bed.

Lepidop′tera. — From the Greek, *lepis*, a scale, and *pteron*, wing. An order of insects.

Lep′tus. — From the Greek, *leptos*, slender. A genus of arachnidans.

Libel′lula.—Latin. A dragon-fly. A genus of insects.

Li′gula.—A part of the lower lip of insects.

Li′mulus.—From the Latin, *limus*, mud. A genus of crusta′ceans.

Locus′ta.—Latin. A cray-fish. A genus of crusta′ceans.

Locus′tæ.—Plural of Locusta.

Luca′nus.—From the Greek, *lukos*, a kind of insect. A genus of beetles.

Luci′fugus. } Latin. Formed from
Luci′fuga. } *lux*, light, and *fugo*, I fly from. Light-avoiding.

Lum′bricus.—A genus of annelidans, and also a genus of entozo′a.

Lum′brici.—Plural of Lum′bricus.

Ly′cosa. — From the Greek, *lukos*, a wolf. A genus of arachnidans.

Ly′cosæ.—Plural of Lycosa.

Macrou′ra.—From the Greek, *makros*, long, and *oura*, tail. A section of decapod crusta′ceans.

Mæ′nas. — From the Greek, *menis*, wrath. Specific name of a crab.

Mam′mal.—Any animal that suckles its young.

Man′dible. — From the Latin, *mandibula*, a jaw. Applied to the lower jaw of mammals, and to both jaws of birds. In insects it is applied to the upper or anterior pair of jaws.

Manduca′tion. — From the Latin, *manduco*, I chew. The act of chewing; mastication.

Mari′nus.—Latin. Marine; belonging to the sea.

Mastica′tion.—The act of chewing.

Max′illa.—Latin. The cheek-bone; a mandible.

Max′illæ.—Plural of Maxilla.

Max′illary. — Relating to the Maxillæ.

Me′dia.—Plural of Medium.

Me′dio-pec′tus. — From the Latin, *medius*, the middle, and *pectus*, breast. The centre of the breast of insects. *See p.* 15.

Me′dio-ster′num.—The central portion of the sternum or breast of insects.

Me′dium.—The substance or matter in which bodies exist, or through which they pass in moving from one point to another. The air, for example, is a *medium*, in which we exist; fishes live in another *medium*.

Medu′sa. — A genus of marine animals of the class Acale′pha.

Medu′sæ.—Plural of Medusa.

Melo-lon′tha. — Greek. From *melon*, an apple, and *anthos*, flower. Generic name of a kind of beetle.

Mem′branous. — Of the nature of membrane.

Men′tum.—Latin. The chin.

Me′sothorax. — From the Greek, *mesos*, the middle, and thorax, the chest. The middle ring of the thorax of insects.

Metamor′phosis. — From the Greek, *meta*, indicating change, and *morphe*, form. Transformation. The change which insects undergo.

Metamor′phoses. — Plural of Metamorphosis.

Me′tathorax. — From the Greek, *meta*, between, and *thorax*, chest. The third ring of the thorax of insects, so called, because it is between the chest and abdomen.

Mi′croscope. — From the Greek, *mikros*, small, and *skopeô*, I view. An optical instrument, by means of which we are enabled to examine minute objects, such as cannot be seen by the naked eye.

Microsco′pic.—Belonging or relating to a microscope.

Mi′gratory. — From the Latin, *migrare*, to move from one place to another. Applied to animals which habitually change their place of residence.

Mol′lusk.—From the Latin, *mollis*,

soft. A peculiar description of soft animal.

Mo'ri.—Latin. Of the mulberry tree.

Mo'rus.—Latin. A mulberry tree.

Mo'tive.—From the Latin, *moveo*, I move. That which moves or sets in motion.

Moult.—To change the feathers; to cast the skin.

Moult'ing.—The act of changing the feathers or casting the skin.

Mus'ca.—Latin. Fly.

Musci'dæ.—From the Latin, *musca*, a fly, and the Greek, *eidos*, resemblance. A section or division of the class of insects, which includes flies.

My'gale.—From the Greek, *mugale*, a field-mouse. A large kind of spider.

My'riapod.—Of the class My'riapoda.

My'riapoda.—From the Greek, *murias*, ten thousand, and *pous*, foot. A class of articulate animals.

Na'tatory.—From the Latin, *nato*, I swim. Swimming, floating.

Nervu'res.—The horny tubes in the wings of insects, which serve to stretch them.

Neurop'tera.—From the Greek, *neuron*, a nerve, and *pteron*, wing. An order of insects.

Nit.—A louse's egg.

Noctilu'cus.—Latin. Belonging or relating to the moon.

Noctur'nal.—From the Latin, *nox*, night. Belonging or relating to night.

Nutri'tion.—The animal function, by which the various organs receive nutritive substances (previously prepared by the several organs of digestion), necessary to repair their losses and maintain their strength.

Nym'pha.—The second stage of metamorphosis of insects.

O'cellar.—Relating to ocelli.

O'celli.—Latin. Plural of ocellus, a little eye.

Œso'phagus.—The gullet.

Œs'tri.—Plural of Œstrus.

Œs'trus.—Latin. A gad-fly.

Onis'cus.—Latin. A wood-louse.

Op'tic.—From the Greek, *optomai*, I see. Relating to vision.

O'ral.—From the Latin, *oris*, the mouth. Relonging or relating to the mouth.

Or'gan.—From the Greek, *organon*, an instrument. Part of an organized being, destined to perform a particular function.

Orga'nic.—Relating to organs.

Organiza'tion.—A mode of structure.

Or'ganism.—The arrangement of organs; the assemblage of their different functions.

Orthop'tera.—From the Greek, *orthos*, straight, and *pteron*, wing. An order of insects.

Orthop'teræ.—Plural of Orthop'tera.

Os'sified.—From the Latin, *os*, bone. Converted into bone.

O'tion.—From the Greek, *ôtion*, a small ear. A genus of cirrhopods.

O'va.—Plural of ovum.

O'vary.—Receptacle of the ova.

O'vum.—Latin. An egg.

O'viduct.—From the Latin, *ovum*, an egg, and *duco*, I lead. The tube which conducts the ovum from the ovary.

Ovi'parous.—From the Latin, *ovum*, an egg, and *pario*, I produce. Applied to animals whose young are born from eggs.

Ovipos'itor.—From the Latin, *ovum*, an egg, and *pono*, I place. The instrument by which insects deposit their eggs.

Ox'ygen.—The vivifying gas, which constitutes about one-fifth of the atmosphere.

Pagu'rus.—Latin. Hermit-crab.

Palæ'mon.—Generic name of prawns.

Pal'pi.—Latin. Plural of Palpus.

Pal'pus.—Latin. A feeler. An organ attached in pairs to the labium and maxilla of insects.

Papi'lio.—Latin. A butterfly.

Parenchy'mata.—From paren'chyma, which is formed from the Greek, *paregchuein*, to strain through; the spongy and cellular tissue of organized bodies. Relating to paren'chyma.

Parasi'ta.—Latin. Parasite.

Parasi'tæ.—Plural of Parasita.

Pa'rasite. — A hanger on, an adherent.

Parasi'tic. — Of the nature of a parasite.

Pari'etes.—From the Latin, pari'es, a wall. The sides or parts forming an enclosure; the limits of different organic cavities are so termed.

Pec'tinate.—From the Latin, *pecten*, a comb. Resembling the teeth of a comb.

Pec'tus.—Latin. The breast.

Ped'icle.—A little foot: a support.

Pedi'culus.—Latin. A louse.

Pedipal'pi. — From the Latin, *pes*, foot, and *palpo*, I feel.

Pe'dipalps. — Name of a tribe of arach'nidans.

Pe'duncle.—A foot-stalk or tube on which anything is seated.

Pel'let.—A little ball.

Pel'try. — From the Latin, *pellis*, skin or hide. The name given to dried skins of animals from which *furs* are prepared.

Pe'netrans.—Latin. Penetrating.

Pentalas'mis. — A genus of Cirrhopods.

Pentame'ran. — From the Greek, *pente*, five, and *meros*, joint. A section of coleopterous insects.

Pentato'ma. — A genus of hemip'terans.

Phalan'gium. — Latin. A genus of arachnidans, including those in which all the legs are very long and slender.

Pha'rynx.—The swallow.

Phile'nor.—Specific name of a butterfly.

Phosphores'cence.—From the Greek, *phôs*, light, and *pherô*, I carry. The emission of light by substances at common temperatures.

Phosphores'cent.—Emitting light at common temperatures.

Physio'logist. — One skilled in physiology.

Phthi'sis.—From the Greek, *phthiô*, I fade. Consumption.

Phytolo'gical. — From the Greek, *phuton*, plant, and *logos*, discourse. Belonging or relating to plants.

Po'lyp. — From the Greek, *polus*, many, and *pous*, foot. A radiate animal.

Po'lypi.—Latin. Plural of polypus.

Po'lypus.—Latin. A polyp.

Polygas'tric. — From the Greek, *polus*, many, and *gaster*, stomach. Having many stomachs.

Polygas'trica. — Latin. Polygastric.

Portu'nus. — Latin. Formed from, *portus*, a port, bay, or haven. Name of a group of crusta'ceans.

Post-pec'tus.—From the Latin, *post*, behind, and *pectus*, the breast. That part of the breast of insects which corresponds to the metathorax.

Post-ster'num. — The posterior part of the sternum.

Prehen'sile.—From the Latin, *prehendere*, to lay hold of. Having the power to grasp or lay hold of objects.

Prehen'sion. — The act of taking hold of. The prehension of food, consists of laying hold of and conveying it to the mouth.

Probos'cis. — A prolongation of the nose or corresponding part.

Processionne'a.—Latin. That goes in procession.

Pro'jectile. — From the Latin, *projicio*, I throw forward. Capable of being thrown forward.

Protho'rax. — The first ring of the thorax.

Ptero'phora. — From the Greek, *pteron*, wing, and *pherô*, I bear. A genus of nocturnal lepidopterous insects.

Pu'lex.—Latin. A flea.

Pulmona'ria.—Latin. Pulmonary.

Pul'monary.—Relating or belonging to the lungs.

Pu'pa. — Latin. A puppet, a baby. The second stage of metamorphosis of insects is so called.

Pu'pæ.—Plural of pupa.

Py'riform.—From the Latin, *pyrum*, a pear, and *forma*, shape. Pear-shaped.

Quadricor'nis. — From the Latin, *quatuor*, four, and *cornu*, horn. Specific name of a crusta'cean.

Radia'ta.—Latin. Radiate.

Ra'diate.—From the Latin, *radius*, spoke of a wheel, a ray. Radiate animals are those of the lowest degree of organization in the animal kingdom.

Ra'mified.—From the Latin, *ramus*, a branch. Branched.

Recu'rved.—Bent backwards.

Reti'culated.—Formed like a piece of net-work.

Retrac'tile. — Susceptible of being drawn back.

Rhipip'tera.—From the Greek, *ripis*, a fan, and *pteron*, wing. An order of insects.

Ri'cinus.—Latin. A tick.

Ros'trum.—Latin. A beak, a snout.

Rotato'ria.—Latin. Rotatory.

Sabel'la.—A genus of cirrhopods.

Sabel'læ.—Plural of Sabella.

Sali'va. — Fluid secreted in the mouth: spittle.

Sa'livary.—Relating to saliva.

Sarcop'tes. — A genus of arachnidans.

Sarcitel'la.—From the Latin, *sarcio*, I patch. A genus of moths.

Scarabe'us. — Latin. A beetle, a chaffer.

Scolopen'dra.—Latin. Generic name of centipedes.

Scor'pio.—Latin. A scorpion.

Secre'te.—From the Latin, *secernere*, to separate. To select and take from the organic fluids, materials peculiarly adapted to the purposes of the organ or agent that secretes.

Secre'tion. — The act or process by which organic structure is enabled to separate from the fluids circulating in it, other different fluids. The fluids thus separated, are termed secretions.

Secre'tory.—Belonging or relating to secretion.

Sedenta'ria.—Latin. Sedentary.

Sedenta'riæ.—Plural of sedenta'ria.

Seg'ment.—A slice, a section.

Ser'pula.—From the Latin, *serpo*, I creep. A family of anne'lidans, which inhabit a calcareous tube, usually adherent to the shells of mollusks.

Ser'rate.
Ser'rated. From the Latin, *serra*, a saw. Having a rough edge like the teeth of a saw.

Serricor'nes.—From the Latin, *serra*, a saw, and *cornu*, horn. A family of coleopterous insects.

Ses'sile. — From the Latin, *sessilis*, dwarfish. Without a pedicle or support.

Se'ta.—Latin. A bristle.

Se'tæ.—Plural of seta.

Seta'ceous. — Of the nature of setæ or bristles.

Seti'gerous. — Having or bearing setæ.

Si'nus.—An excavation or hollow.

Spin'nerets.—*Spinners.* Organs with which insects spin their silk or web.

Ster'nal.—Belonging or relating to the sternum.

Ster'num.—The breast-bone.

Stig'mata.—A spiracle or breathing-hole, forming the external opening of the tracheæ or air-vessels, in insects.

Sti'let.—A little stile or point.

Sty'liform.—In shape of a stile.

Sucto'ria.—Latin. Suctorial.

Sucto'rial.—From the Latin, *sugo*, I suck. Applied to those tribes of insects, crustaceans and annelidans, which are provided with suckers.

Sypho'stoma.—From the Greek, *siphon*, a tube, and *stoma*, mouth. A genus of annelidans.

Tæ'nia. — From the Greek, *tainia*, a fillet. A tape-worm.

Tali'tra.—A genus of crusta'ceans.

Taren'tula. — From *Tarentum*, a town in Italy. A genus of arach'nidans.

Tar'si.—Plural of tarsus.

Tar'sus. — The fifth section or division of the leg of insects, or foot.

Tegena'ria.—From the Latin, *tegere*, to conceal. A name applied to the family of spiders.

Teg'ument.—From the Latin, *tego*, I cover. A covering; the skin, for example.

Tegumen'tary. — Belonging or relating to the tegument.

TEN′TACLE.—From the Latin, *tentaculum*, a holder. Certain appendages about the mouth of insects, &c.

TENTA′CULAR.—Belonging or relating to ten′tacles.

TEREBRAN′TIA.—From the Latin, *terebro*, I bore. A section of hymenopterous insects.

TERIBEL′LA. — A genus of annelidans.

TER′MITES.—From the Latin, *termes*, a branch of a tree. A tribe of neuropterous insects.

TERRICO′LA.—From the Latin, *terra*, earth, and *colo*, I inhabit. A division of annelidans.

TESTA′CEOUS. — From the Latin, *testa*, a shell. Of the nature of shells.

TETRAME′RANS. — From the Greek, *tetteres*, four, and *meros*, joint. A division of coleopterous insects.

THELPHU′SA. — A genus of crusta′ceans.

THORA′CIC.—Belonging or relating to the thorax.

THO′RAX.—The chest.

THYSANOU′RA. — From the Greek, *thusanai*, fringes, and *oura*, tail. An order of insects.

TI′BIA.—A leg.

TI′BIÆ.—Plural of tibia.

TI′NEA.—Latin. A moth-worm, that eats clothing, books, &c.

TI′NEÆ.—Plural of tinea.

TIS′SUE.—From the Latin, *texere*, to weave. The substances of which the organs are composed.

TRA′CHEA (*tra′ke-a*).—Wind-pipe; a tube conveying air.

TRA′CHEÆ.—Plural of trachea.

TRA′CHEAL (*tra′ke-al*). — Relating to trachea.

TRACHEA′RIA. — Latin. Tracheal; having tracheæ.

TRI′LOBITE.—From the Latin, *tres*, three, and *lobus*, lobe. A fossil crusta′cean.

TRIME′RANS.—From the Greek, *treis*, three, and *meros*, joint. A division of coleopterous insects.

TRIRA′DIATE.—From the Latin, *tres*, three, and *radius*, ray. Three-rayed.

TRITO′RES. — Latin. Grinders; triturators.

TUBICO′LA.—From the Latin, *tubus*, a tube, and *colo*, I inhabit. A genus of anne′lidans.

TU′BICOLE.—Tube-inhabiting.

TU′BERCLE.—A small tuber; a little knot or nob.

TUR′BINATED. — Shaped like a top or pear.

UTRI′CULA.—Latin. A little bladder or sac.

UTRI′CULÆ.—Plural of utricula.

VAGABUN′DÆ.—Latin. Vagabond.

VANES′SA.—From the Greek, *phanes*, one of the names of Venus. A genus of butterflies.

VAS′CULAR. — Having numerous vessels.

VE′NOUS.—Relating to the veins.

VEN′TRAL.—Belonging or relating to the belly.

VEN′TRICLE.—A little belly; a small cavity.

VER′TEBRATE. — Having vertebræ, or a spine.

VESICATO′RIA. — Latin. Vesicating, blistering. Specific name of the Spanish-fly.

VE′SICLE.—A little bladder.

VES′PA.—Latin. A wasp.

VES′PIARY.—A wasp's nest.

VIS′CERA.—Plural of viscus.

VIS′CUS. — Any internal part, as the intestine, &c.

VITA′TA.—Latin. Avoided, shunned. Specific name of a fly.

VI′TREOUS.—From the Latin, *vitrea*, glass. Resembling glass; of the nature of glass.

VULGA′RIS.—Latin. Common.

XI′PHOSURA.—From the Greek, *xiphos*, a sword, and *oura*, tail. Name of a tribe of crusta′ceans.

ZOOL′OGY. — From the Greek, *zôon*, an animal, and *logos*, a discourse. The science of animals.

ZOOLO′GICAL.—Belonging to zoology.

ZO′OPHYTE.—From the Greek, *zôon*, an animal, and *phuton*, plant. A plant animal.

THE END.

RECOMMENDATORY NOTICES.

OPINION OF WILLIAM S. ZANTZINGER, M.D.

MESSRS. TURNER AND FISHER :—

The flattering reception which the previous volumes of Dr. Ruschenberger's Series have met with from the public, has already proved that his efforts to diffuse a taste for the study of Natural History, especially among the younger members of the community, and the means selected for the purpose have been fully appreciated. Any commendation of the present number of the Series, "*The Elements of Botany,*" would therefore seem almost superfluous.

It is certainly admirably adapted for "beginners, whether young or old," containing a large amount of information in a small compass, and easy of comprehension.

WILLIAM S. ZANTZINGER, M.D.

Philadelphia, April 25, 1844.

OPINION OF SAMUEL GEORGE MORTON,

Professor of Anatomy and Physiology, Pennsylvania Medical College.

MESSRS. TURNER AND FISHER :—

I have carefully examined the *Elements of Botany,* constituting part of Dr. Ruschenberger's Series of "First Books of Natural History," and am highly pleased with the plan and details of the work. It appears to combine whatever is requisite in elementary science, and is well calculated to mingle pleasure and instruction in the mind of the learner.

SAMUEL GEORGE MORTON, M.D.

May 7, 1844.

OPINION OF THOS. D. MÜTTER, M.D.

Professor of the Institutes and Practice of Surgery, in the Jefferson Medical College, Phila.

MESSRS. TURNER AND FISHER :—

Gentlemen, — I have just examined the "*Elements of Botany,*" by Dr. Ruschenberger, and heartily recommend the work to the notice of all who desire information on the subject of which it treats. Like the previous numbers of the Series, it fully sustains the high reputation of its author.

Respectfully, yours, &c.

THOS. D. MÜTTER, M.D.

OPINION OF JOSEPH CARSON, M.D.

Professor of Materia Medica in the Philadelphia College of Pharmacy.

To MESSRS. TURNER AND FISHER :—

I have examined the "*Elements of Botany,*" belonging to Ruschenberger's Series, and regard it as the best book of the kind that has fallen under my observation. The descriptions are accurate; and, as every thing required by the learner is presented succinctly and lucidly, a full knowledge of rudimentary Botany may be obtained from it. As a pocket volume, it will be of advantage to the adept, who has occasion often to refresh his memory upon first principles. Even the general reader may derive information from the account of plants employed in the arts, or affording articles of luxury. Modest as is the form of this little production, it is endowed with high merit, and cannot fail to be useful to the public, by whom it will be appreciated.

Very sincerely, &c.

J. CARSON.

Philadelphia, April 18, 1844.

OPINION OF ROBERT BRIDGES, M.D.

Lecturer on Chemistry.

MESSRS. TURNER AND FISHER :—

Gentlemen,—I have read and examined somewhat in detail the "*Elements of Botany,*" by Dr. Ruschenberger, and can state with pleasure that it is calculated to sustain the reputation of the Series of "First Books," of which it constitutes a part.

Very respectfully, yours, &c.

ROBERT BRIDGES.

Philadelphia, April 20, 1844.

RECOMMENDATORY NOTICES.

OPINION OF THE RIGHT REV. CHAS. P. McILVAINE, D. D.

Bishop of the Protestant Episcopal Church, Diocese of Ohio; President of Kenyon College, &c.

Kenyon College, Gambier, Ohio, Feb. 1842.

Messrs. Turner & Fisher:

Gentlemen,—On reaching home, after a long absence, I had the pleasure of reciving the copy of the work prepared by Dr. Ruschenberger on Physiology and Animal Mechanism, for the use of schools. If my opinion of its merits can be of any service to its circulation, I am free to say that not only are the subjects of the work such as ought to enter into the course of study of the higher classes of our schools, but this work seems to me to be well adapted to the want of schools in reference to its subjects. At any rate, I know not a better for its professed purposes.

Yours, very truly, and respectfully,

CHAS. P. McILVAINE.

OPINION OF THE HON. LEVI WOODBURY,

United States Senator from New Hampshire.

Washington, 28th Jan. 1842.

Messrs. Turner & Fisher.

Gentlemen,—Yours of the 22d inst, has been received, with the First and Second Book on Natural History, which you have recently published.

I have examined them with some care and appreciate the plan of communicating the elements of this interesting branch of science in so cheap and clear a form.

With my best wishes for the success of your enterprise,

I am, respectfully,

LEVI WOODBURY.

OPINION OF THE HON. DANIEL STURGEON,

United States Senator from Pennsylvania.

Senate Chamber, Washington City, Jan. 29th, 1842.

Messrs. Turner & Fisher.

Gentlemen.—I have examined with some care the two small volumes you were so kind as to send me.

I think Dr. Ruschenberger has succeeded in condensing into as small a space as possible, much valuable information on the subject of which he treats, and think the work admirably calculated to impart general knowledge on this interesting subject.

I will be pleased to see it adopted in our high schools and colleges as a text book.

With sentiments of respect and esteem, yours,

DAN'L STURGEON.

OPINION OF THE HON. SAMUEL L. SOUTHARD,

United States Senator from New Jersey.

Washington, Feb. 15th. 1842.

Messrs. Turner & Fisher.

Dear Sirs,—I am gratified by your kindness, in sending me the two volumes referred to, in your letter of the 31st of January. I entirely concur in the objects you desire to accomplish. Few things can be more important to our common country. My incessant and inexorable duties, have, thus far, prevented me from making that examination of the volumes which I desire.

I am respectfully, &c. &c.

SAMUEL L. SOUTHARD

RECOMMENDATORY NOTICES.

OPINION OF GEORGE M'CLELLAN, M. D.

Professor of the Institutes and Practice of Surgery, in the Pennsylvania College of Medicine.

Messrs. Turner & Fisher.

I have examined the two first of the Series of Dr. Ruschenberger's First Books of Natural History, with much attention, and take great pleasure in giving my opinion in their favour. They are admirably calculated to diffuse a sound knowledge of first principles in the sciences. They are *axiomatic* in their design and character, and are constructed on the true principles of inductive philosophy. The general propositions all comprehend true minor ones, and also the individual facts. They appear to me to have been drawn up according to Bacon's strictest method of exclusions and rejections. I have made the first of the series a text book in my private class; and have found it to facilitate the business of communicating an accurate and precise knowledge to the best educated among the students of medicine and surgery.

GEORGE M'CLELLAN.

Philadelphia, March 7. 1842.

OPINION OF THO'S D. MÜTTER, M. D.,

Professor of the Institutes and Practice of Surgery, in the Jefferson Medical College, Philadelphia.

Philadelphia, Jan. 18, 1842.

Dr. Ruschenberger.

Dear Dr.—I have carefully examined the "Second Book" of your very valuable series on "Natural History," and cordially unite with many others in bearing testimony to its merits.

The study of Natural Sciences has been too much neglected in our "systems of education," and nothing can remedy the evil but the publications by individuals whose reputations will be a sufficient guarantee to the public as to the value of their labours of well arranged, lucid, and at the same time scientific works upon these subjects. I need hardly say that the series now under issue, possesses all the attributes of success.

Very faithfully, yours,

THO'S D. MÜTTER.

OPINION OF ROBERT M. BIRD, M. D.

Professor of Materia Medica, and the Institutes of Medicine, in the Pennsylvania College of Medicine.

Philadelphia, February 21, 1842.

My Dear Doctor.

After a very careful examination of your *Mammalogy*, or *Second Book of Natural History*, from the text of Edwards and Comte, it affords me pleasure to bear witness to its merits. It is, like the First Book of the Series, on Physiology and Animal Mechanism, extremely well adapted to the purpose for which it was written, of opening to the pupils of our higher schools and colleges, the great field of Natural History, and grounding them in the principles of classification, while imbuing them with a love of the science and the introduction of such works into our schools, cannot be otherwise than favourable to the interests of education.

Very respectfully yours, &c,

ROBERT M. BIRD.

W. S. W. Ruschenberger, M. D.

RECOMMENDATORY NOTICES.

OPINION OF THE HON. G. C. VERPLANCK.

Late United States Senator from New York; and now one of the Trustees the Public Schools.

New York, Feb. 7, 1842.

MESSRS. TURNER & FISHER.

Gentlemen,—I find among other papers which my absence from the city has occasioned me to neglect, a note from you accompanying Dr. Ruschenberger's little work on Natural History, which was received on the day I left town for an absence of some time.

I have since examined the volume with much pleasure. I think it exceedingly well executed, communicating much information in an unpretending manner, and calculated to be very useful and acceptable to those for whom it is specially designed. I am, your ob'dt serv't,

G. C. VERPLANCK.

OPINION OF S. S. HALDEMAN, ESQ.

Zoologist and Lecturer on Zoology.

Philadelphia, February, 1842.

MESSRS. TURNER & FISHER.

I have seen no work of the same extent, which contains so much useful matter on Zoology, as the "Elements" of Milne Edwards; and Dr. Ruschenberger deserves the thanks of the public for making it the basis of of his Zoological volumes. His additions to the part devoted to "Mammalogy," are judicious; and his constant adherence to the true, or scientific names of animals, is a step to which the authors of elementary works seldom advance. For this feature, and the glossary of technical terms, the student will be greatly indebted to him. I can confidently recommend the "Mammalogy" as better calculated to fulfil the objects intended, than any other work with which I am acquainted. Yours, &c.

S. S. HALDEMAN.

OPINION J. AUGUSTINE SMITH, M. D.

President of the College of Physicians and Surgeons, and Professor of Physiology, Crosby Street School.

No. 5 Carroll Place, New York, Jan. 20, 1842.

MESSRS. TURNER & FISHER.

Gentlemen,—I have received and examined your "Second Book of Natural History, prepared by Dr. Ruschenberger," and I can truly say I am acquainted with no work of the same size containing an equal amount of useful, accurate, and entertaining knowledge. I therefore hope and believe it will not fail to receive the encouragement extended to the first volume of the series. Respectfully, your ob't serv't,

J. AUGUSTINE SMITH.

OPINION OF ALBAN GOLDSMITH, M. D.

New York, Jan. 17, 1842.

MESSRS. TURNER & FISHER.

Gentlemen,—I have received your Second Book of Natural History, prepared for the use of schools. I am very much pleased to hear that your First Book has been adopted by the Public Schools in Pennsylvania, and I trust the example will soon be followed by all the States of the Union, for nothing expands the mind so much as the book of Nature. And I look upon the introduction of the study of Natural History into common schools as a bright spot in the progress of mental culture.

Yours, truly,

ALBAN GOLDSMITH.

RECOMMENDATORY NOTICES.

OPINION OF THOMAS HARRIS, M. D.,

Surgeon, United States' Navy, President of the Medical Society of Philadelphia, &c. &c.

Philadelphia, August 5th 1841.

Dear Sir,—I have examined with care your "First Book of Natural History," and am of opinion that the work is well calculated, by its simple language and lucid arrangement, to convey the elementary knowledge of which it treats. Designed, as it is, for the use of schools and colleges, I have great pleasure in recommending it, as being the best of its kind which has yet been offered to the public.

I am, very truly and sincerely,

THOMAS HARRIS.

Dr. W. S. W. Ruschenberger, *U. S. Navy.*

EXTRACT FROM THE BOSTON MEDICAL AND SURGICAL JOURNAL.

Physiology and Animal Mechanism.—W. S. W. Ruschenberger, M. D., of the navy, has prepared a useful book, of small dimensions, principally from the text of Milne Edwards and Achille Comte, which will doubtless be well received. It is principally designed for the use of schools and colleges; yet from a slight examination of the pages, we are sure it would do no injury to those who have long since received university honours, were they to review former studies through the agency of this publication.

OPINION OF NATHAN W. COLE, M. D.

Burlington, August 2d, 1841

My Dear Sir,—I have read with much pleasure the little volume of "Natural History" you were kind enough to send me. Combining, as it does, a lucid arrangement with simplicity of language, upon subjects important and interesting, it cannot fail, I think, in becoming the class-book of our public schools.

Should the work be fairly appreciated by teachers and others connected with the education of youth, your own expectations will be more than gratified.

Accept, dear sir, my earnest wishes for the success of your labours, and believe me to be,

Yours sincerely,

NATHAN W. COLE.

Dr. Ruschenberger.

OPINION OF CHARLES ATHERTON, ESQ.,

Teacher.

Burlington, 8th mo., 3d, 1841.

Dr. W. S. W. Ruschenberger.

I have examined the little work on "Physiology and Animal Mechanism," which was left with me by Wm. P. Israel, with much satisfaction. It supplies a want which I have no doubt many other teachers, besides myself, have felt in our schools. There is certainly no subject more deserving the attention of the juvenile mind than the structure of these bodies, which we bear about with us, and upon the proper and healthy condition of which, our happiness in this world so much depends. My impressions are, that the work in question is suitable for school instruction. It appears to be well-arranged, and concise in expression—two qualities of essential importance in a school-book.

Thine, respectfully,

CHAS. ATHERTON.

RECOMMENDATORY NOTICES.

It is sufficient to say for it that the original is used in France by order of the Minister of Public Instruction. Dr. Ruschenberger, the accomplished translator, has added original notes and questions upon the text, which are a great improvement upon the French plan. The propriety of making physiology and the kindred branches of science subjects of study in primary schools, is too apparent to require enforcement. Dr. Ruschenberger has well applied his knowledge and taste in this volume, and we hope that he will follow it by others explanatory of the sciences which pertain to his professional studies.—*Philad. Nat. Gaz.*

We commend the work to the attention of those concerned, as admirably adapted to the use of schools. The correctness of the descriptions, and of the plates illustrative of the text, is vouched for by the most scientific of our city.—*U. S. Gazette.*

From a hasty glance at the work, the recommendation of a number of distinguished professional men, and the eminent character of its author, we have no doubt it will prove a valuable acquisition in schools and colleges.—*American Sentinel.*

The plates are correctly drawn, and will serve as a useful auxiliary to the young student in this branch of education.—*Boston Traveller.*

The style is plain and comprehensive. Such a work is much needed among the text books of our schools and colleges,—none, male or female, should be without it. We heartily recommend it to the notice of teachers and pupils; for it is one of the most valuable acquisitions of the day to the catalogue of school books.—*Southern Lit. Mes.*

The work is one of merit, and will find speedy and permanent success. The subject of which it treats is one of great importance, and one on which we are surprised to find such general ignorance existing.—*Sat. Eve. Post.*

It has too frequently been an error with the authors of scientific works designed for beginners, to degrade their style to the assumed intellectual inferiority of their readers. In the fear of not being understood, they omit proper scientific names in preference to those in common usage which but partially convey the intended meaning and that in the most vague and general manner. This we are convinced is altogether wrong; for independent of the limited ideas necessarily incident to such a style, the other when adopted, can be mastered more readily than the casual observer would at first suppose, and with the aid of a glossary, all difficulty at once vanishes. The work under notice is a clear instance of the correctness of our position. Although strictly elementary in its design, it never yields its scientific claims to the pretensions of popular phraseology. But to obviate any difficulty that might arise, an admirable glossary is affixed. This with the accurate plates referred to by numbers in the text, not only renders its comprehension easy, but its study agreeable. Independent of the abstract merits of the work, it supplies a place in the young scholar's library, which has long been vacant. While almost every department of knowledge has been made more plain, and pleasant by a multiplication of books and charts, each succeeding one improving on its predecessor—this we believe is the first of its kind offered by an American publisher to teach "the proper study of mankind."

The "First Book of Natural History" will very soon find a place in all our seminaries of learning. The general reader, likewise, who may wish to inform himself of the circulation of the blood, of respiration, digestion, the nervous system, &c., may, by means of this work, save himself much laborious research in professional treatises.—*Del. State Journal.*

We have rarely perused a school book containing so much valuable information in so small a compass, and so admirably arranged as well as peculiarly suited to the quick comprehension of learners. Indeed, there is in the book a store of information for many who have not had, and may never have, the leisure to search the source from which it is derived. The work is highly recommended by scientific, literary, and particularly medical men, and we concur in their opinion of its value, and of its usefulness as a standard book for schools.—*N. Y. Standard.*

This work is sent forth to the public with the strongest recommendations, and we doubt not it will have, as it deserves, a most extensive circulation.—*N. Y. Times and Evening Star.*

This work is one of great merit, and the author has shown himself well-versed in the important and deeply interesting science of which he has so ably treated.—*N. York Planet*

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